Embracing the Potential of Offshore Wind in Connecticut

A Study of Opportunities & Challenges

December 22, 2021

Chamber *of* Commerce
Eastern Connecticut

Connecticut®

PREPARED BY McAllister Marine Engineering

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Foreword

Society is at a critical juncture: we must choose to invest in renewable energy sources to power our future or continue to suffer the consequences of extreme weather brought on by global climate change seriously impacting lives and property. This was brought home over the past few years as we witnessed increasingly dangerous and erratic weather, fueled by a changing climate, causing major disasters in this country and across the globe.

Offshore wind expansion in the United States is not the only mitigation for climate change, but it is certainly an important component in our efforts to decarbonize our energy production – this means reducing CO_2 by replacing coal, oil and natural gas-fired power generation and replacing them with renewable energy sources including on- and offshore wind, solar and hydroelectric sources of energy. We applaud Governor Lamont and his team for recognizing how critically important it is for Connecticut to transition to renewable energy sources.

This new-to-the U.S. industry is set for exponential clean energy and related economic growth in the coming decades. With the potential for 30 GW of offshore wind-derived power by 2030, and 110 GW by 2050, states along the East Coast, including Connecticut's neighbors, are vying for the opportunity to lead the nation's offshore wind activities efforts. This region, and Connecticut specifically, is positioned to be a leader in offshore wind development and to serve as a primary hub for Offshore Wind activities at all stages in the developing U.S. offshore wind marketplace.

Why is this important to the people of Connecticut? The offshore wind industry represents a once-in-a-generation opportunity for the country and the world to actively pursue clean and renewable sources of energy which will enable rapid decarbonization to combat the effects of global climate change. Achieving the Biden Administration's 2030 target of 30 GW of offshore wind power would reduce greenhouse gas emissions by 78 million metric tonnes per year. Offshore wind expansion will require the domestic expenditure of billions of dollars over the coming decades and result in tens of thousands of jobs, both in the United States and internationally[1]. Now is the time for Connecticut to act and capture as many of the jobs and economic benefit as possible as the U.S. offshore wind marketplace develops. If we do not act, or inter-state competition "*gets in the way,*" there is the real potential that European-based offshore wind developers may construct their U.S. projects from fabrication/manufacturing facilities located in Europe, thereby resulting in the loss of well-paying jobs for the State.

To date, Connecticut has been heavily involved in the initial startup of the industry in the U.S. with two early awarded offshore wind projects. However, to remain relevant and active as the industry grows and matures, the State needs to develop and grow an effective strategy to attract the industry - through our existing talented and experienced workforce, supply chain opportunities, and our deep-water port facilities that have no overhead restrictions – all critical infrastructure metrics for the industry. Connecticut must be ready to support the local manufacturing of components for first-mover offshore wind projects and the marshalling of projects from port facilities located near the offshore wind farms.

To help realize this goal, the Chamber of Commerce of Eastern Connecticut set out to undertake this study to gain a better understanding of where the offshore wind market currently is, and more importantly,

[1] https://www.whitehouse.gov/briefing-room/statements-releases/2021/03/29/fact-sheet-biden-administration-jumpstarts-offshore-wind-energy-projects-to-create-jobs/

where it is headed. Our goal is to recommend and promote targeted investments within the State to capitalize on what has the potential to be a hundred-billion-dollar[2] industry. To achieve this goal, we engaged with industry experts, including developers, OEMs, government agencies, non-offshore wind manufacturers, workforce development agencies, and other experts to help us gain domestic and global insight on the Connecticut's positioning. Our team reviewed existing reports, market projections, conducted numerous interviews and discussions, and participated in multiple offshore wind industry webinars and conferences to ensure that our information was both accurate and timely. We were also very careful to note when and where detailed industry information was not available, typically due to proprietary concerns, as well as the nascent nature of the U.S. offshore wind marketplace.

To this end, - this report highlights the potential benefits of offshore wind development to Connecticut, and identifies recommendations and key strategies related to 1) Ports; 2) Supply Chain; and 3) Workforce. Specifically, the report describes the existing port infrastructure within the State and what can be adapted to offshore wind and the supply chain needs and opportunities, including those that could be captured by existing manufacturers within the State. It also illustrates the jobs associated with planning, constructing, and servicing offshore wind projects, and the training and education programs needed to develop the soon-to-be-needed workforce.

Putting together this document was a collaborative effort of a dedicated team of motivated professionals from several companies and agencies. This report represents a realistic roadmap of actions that the State could take to fully-anchor its position as a key offshore wind hub in the U.S. While this report was not commissioned by the State, the Governor, or any State agency, it was prepared to highlight the benefits and propose actions that will benefit the State throughout and we hope that the State will find this report to be a valuable tool for use in planning and actions relative to offshore wind.

We could not have undertaken such a monumental effort without the assistance of some very talented, experienced, and knowledgeable people and teams, and we would like to explicitly thank them for their contributions. It should be noted that some of the following entities contributed directly to the creation of the report, while others were willing to talk to the project team in general about their area of expertise. A special thank you to the people with whom we met and discussed the project with. They include:

- Ørsted –David Ortiz
- Eversource – Michael Ausere, Raymond Collins
- Connecticut Department of Economic and Community Development – Alexandra Daum, Aaron Knight, and Tony Roberto
- Connecticut Department of Energy and Environmental Protection – Lauren Savidge and Vicki Hackett
- CT Port Authority – John Henshaw and Andrew Lavigne
- The Connecticut Office of Workforce Strategy - Collin Cooper, Niall Diamondo, Kelli Vallieres and Elaine Ulrich
- Connecticut Center for Advanced Technology – Ron Angelo and Joel Rinebold
- Park City Wind - Chris Bradford and Marcus Brown
- The Mohegan Tribal Nation - Chief of Staff Chuck Bunnell
- The Mashantucket Pequot Tribal Nation - Jean Swift

[2] Report: Offshore wind supply chain worth $109B over 10 years - ABC News (go.com)

- Eastern Connecticut Workforce Investment Board– Mark Hill
- U.S. Army Corps of Engineers – Mike Walsh
- Aerospace Components Manufacturers – Paul Murphy
- General Electric – Derek Stillwell
- Mohawk Northeast (NE) – David Schill and Russ Heinke
- Crowley Maritime – Edward Anthes-Washburn
- Naval and Maritime Consortium – Walker Potts
- Cross Sound Ferry – John P. Wronowski and Stan Mickus
- Eastern Advanced Manufacturing Alliance – John Murphy
- New London Mayor Michael Passero

Again, thanks to all participants who contributed to this important study. Now is the time to harness the potential of the East Coast offshore wind industry and to set the stage for Connecticut to lead the nation in this exciting new and necessary venture.

Tony Sheridan
President & CEO
Chamber of Commerce of Eastern Connecticut

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Executive Summary

The offshore wind (OSW) industry is poised to take off in the United States with significant growth and opportunity being projected from 2021 out through 2050 and likely beyond. The Block Island Wind Farm developed by Deepwater Wind (now part of Ørsted) was the first wind farm installed in U.S. waters (state waters of Rhode Island), and now Vineyard Wind 1, to be located in the Bureau of Ocean Energy Management (BOEM) Wind Energy Area (WEA) located south of Martha's Vineyard, is the first utility-scale project that has received all the required federal authorizations for construction in federal waters. This first, grid-scale project is set to kick start the OSW industry with 15[3] additional utility-scale projects in the federal permitting queue, making 16 total active OSW projects. The East Coast is the prime location to support the OSW industry start-up, with consistent strong winds, amenable geologic/geotechnical bottom conditions, and relatively shallow water depths, which allow for the use of fixed-foundation turbines. Several states along the East Coast are attempting to position themselves for leadership in the OSW industry, and this *Offshore Wind Strategic Study* was commissioned by the Chamber of Commerce of Eastern Connecticut (hereinafter referred to as the Chamber), Ørsted and Eversource to create a list of recommendations for how Connecticut can build on its existing strengths and advantages to capture future benefits of the offshore wind industry.

Where do Connecticut's strengths lie with respect to OSW? For one, Connecticut's deep-water ports are particularly accessible to the BOEM existing WEAs and future Northeast call areas, in that these ports have no overhead restrictions (i.e., no bridges or overhead power lines). This is significant as OSW developers prefer to ship their massive components in a vertical position from port to the offshore lease areas – bridges and powerlines downstream of many U.S. port facilities encumber their future utility to the OSW industry. Furthermore, Connecticut has a storied maritime history with a well-developed supply chain already built around General Dynamic's Electric Boat (EB) operations, which has resulted in a robust, developed set of suppliers and manufacturers able to pivot to support the OSW wind marketplace. In addition, the technology and advanced manufacturing capabilities of the aerospace industry within the State puts it in a unique position to adapt to some of the advanced manufacturing requirements of fixed-bottom wind turbine generators (WTGs) – this is a critical State strength as existing assets can quickly pivot to OSW-related manufacturing for the early-mover projects, thereby allowing developers and Original Equipment Manufacturers (OEMs) to show local content and net economic benefits associated with their U.S. projects. These technology and advanced manufacturing capabilities will also prove useful as the OSW industry matures and the anticipated uses of floating foundations (for future BOEM lease areas which are in deeper waters with less amenable geologic characteristics) and concrete gravity-based structures (GBS)-type foundations (to minimize impacts to marine life during installation). Lastly, Connecticut has a knowledge and talent base that, with some targeted development programs, could expand to develop a steady pipeline of qualified and highly skilled workforce for the OSW industry.

Recently, President Biden's administration committed to developing 30 gigawatts (GW) of offshore wind power by 2030. Other OSW-industry models show the potential of up to 110 GW of OSW by 2050[4], and that is the U.S. market alone. All of this means that the U.S. OSW-related industries are going to experience

[3] Offshore Wind Market Report: 2021 Edition (energy.gov) Page 10

[4] Offshore Wind Market Report: 2021 Edition (energy.gov) Page xii

tremendous growth in the coming decades, providing clean, renewable, and reliable energy, tens of thousands of good, high-paying jobs, and significant amounts of other economic benefits.

With the two OSW projects procured by the State currently in development, and the potential for an additional 1,196 megawatts (MW) of capacity, Connecticut has established itself as an early leader in the U.S. OSW industry. Several neighboring states have since made significant efforts to establish themselves as the "center of the OSW universe" and have had some success in doing so[5]. While Connecticut was an early marketplace leader, the State should continue its efforts and develop more programs to maintain and build its stature as a significant part of this developing industry. This study was created to discuss where the industry is going and what activities and programs the State of Connecticut should consider undertaking to be relevant and ensure that its citizens thrive as part of the new, green, and clean economy.

To develop this Connecticut Offshore Wind Strategic Study for the Chamber of Commerce of Eastern Connecticut (hereinafter referred to as "the Chamber"), McAllister Marine Engineering, LLC (MME) evaluated the following issues/metrics related to OSW:

- The current state of the OSW market and where it is heading from 2021 through 2035 and 2050.
- The needs and desires of OSW developers and OEMs relevant to the U.S. market, as well as the potential for U.S.-based manufacturers to support the international OSW marketplace.
- Infrastructure and port requirements for the industry.
- The supply chain for WTGs and where supply chain opportunities exist within the State.
- The workforce skills needed for OSW and how to maintain and develop a pipeline of talented workers within the State to fully support early-mover OSW projects, as wells a long-term, follow-on projects.

The OSW industry will develop in the U.S. within the three following targeted areas: 1) through ports and physical infrastructure; 2) through a U.S. and worldwide supply chain; and 3) through a talented, trained, and skilled workforce. While these three targeted areas each have their distinct characteristics, each one interacts and benefits from the other, and thus, by targeting available State investments strategically, Connecticut can optimize its position within this industry. It should be noted that it will not be realistic or feasible for one state to capture all the offshore wind industry, and several aspects of the industry have already been established across the Northeastern U.S. MME developed the following recommendations aimed at enabling the State to establish itself more-fully within the developing OSW marketplace. As discussed above, the offshore wind marketplace is now taking off and to ensure that Connecticut is not left behind, it is recommended that the State act quickly and effectively to capture its fair share of the coming billions of dollars that will be invested over the next few years by considering taking these strategic steps:

- Create a centralized State agency or multi-agency committee dedicated with the development of the OSW industry. This agency would establish itself as the central contact, clearinghouse, and promoter of all things OSW within the State. The State should "*make it easy*" to do business with and provide one-stop shopping for State businesses and entities which may want to anchor their operations in Connecticut.

[5] Governor Hochul Announces Largest, Single New York State Offshore Wind Supply Chain Award of $86 Million to Support Sunrise Wind Project (ny.gov), Thinking locally: Experts applaud N.J.'s efforts to source massive offshore wind turbine parts right here in state | ROI-NJ

- Create a regional partnership playing to the strengths of each of the states in the region. Part of this should also be a strategic alliance with other interested states, to amplify their respective positions and power in the region. It is widely believed in the OSW industry that there will be more than sufficient net economic benefits for all states. By working collaboratively in an interstate fashion, the U.S. can more-quickly become ready to support the industry in establishing a U.S. based supply chain.
- Create a significant funding mechanism for ports development. OSW components are so massive and heavy, and existing port infrastructure and availability is so limited that investments are needed to redevelop and upgrade port facilities so that they can support the deployment and maintenance of OSW wind farms. By anchoring OSW port operations in the State, Connecticut would realize significant short- and long-term net economic benefits.
- Dredge Bridgeport Harbor. Bridgeport is one of three deep-water ports within the State (the others are New London Harbor and New Haven), but years of shoaling and sedimentation have reduced depths, and without dredging of the harbor in the near future, the channel depths will represent a significant limitation and hindrance to future development and deployment of OSW activities from the harbor.
- Actively promote the State, its existing capabilities and infrastructure. Connecticut has a lot to offer; however, the industry is starting to move so fast up and down the East Coast, that in order to capture the attention of the industry, the State needs to actively advocate for its strengths and position in the marketplace. This would mean hosting and creating presentations for developers and OEMs, and actively promoting the in-State supply chain and workforce.
- Promote the existing advanced manufacturing industry into the Tier 2 and Tier 3 supply chain for the OEMs, with a focus towards the nacelle subassemblies.
- Develop and maintain its OSW Supply chain database. Each state is developing or has developed a supply chain database. Connecticut needs an effective communications tool for all of the players in the offshore wind industry, the database needs to be up-to-date, broad, and have an easy-to-use interface.
- Focus on the workforce that will be needed for the future of OSW. In particular, this would involve wind engineering programs, and promoting welding and steel working capabilities.

OSW is an exciting and rapidly developing industry, and with focus and dedication, the State of Connecticut has the opportunity to establish itself as a center of knowledge and a major contributor to the U.S. and worldwide supply chain. The next three decades are likely to provide rapid growth and significant economic impact, so these strategic actions and investments made in the near term will provide benefits and rewards for years to come.

1. Introduction

Connecticut is a strategically positioned state that has abundant and high-quality coastal and inland resources, and infrastructure. Those resources, combined with its long history and experience in servicing the maritime and aerospace industries, position the State to become an integral part of the developing offshore wind (OSW) industry in the United States.

Connecticut is committed to offshore wind, not only for its economic benefits, but also for the environmental benefits associated with this clean and renewable energy source. Governor Ned Lamont signed Public Act 19-71 into law in June 2019, authorizing the Department of Energy and Environmental Protection (DEEP) to procure up to 2,000 megawatts (MW) of offshore wind energy. He also issued Executive Order No. 3 calling for Connecticut to transition to 100% zero-carbon energy by 2040.

As a result of the initial 2019 procurement, Connecticut has two active offshore wind projects currently in development; Revolution Wind, being developed by Ørsted and Eversource; and, Park City Wind, being developed by Avangrid Renewables. Revolution Wind is a 704 MW joint procurement with Rhode Island, with the deployment and marshalling to be based out of New London, at the State Pier Facility. Park City Wind is an 804 MW project with a base of operations to be developed in Bridgeport, likely working out of the Barnum Landing property.

In addition to the commitments and procurements being made, the State is also investing to redevelop State Pier in New London through a partnership with Ørsted and Eversource (Revolution Wind). This investment will transform the State Pier into a heavy-lift, deep-water port with no air draft restrictions, making it one of the most attractive port facilities on the East Coast for offshore wind developers. State Pier will not only support Revolution Wind but also Sunrise Wind and the South Fork projects[6] as a marshalling port. The facility improvements are expected to be completed by 2023 and if it is not utilized in the future for the Ørsted and Eversource projects, it would be available and be a highly desirable asset to other OSW developers.

The State has recognized that supply chain development and workforce training are essential pieces to aid Connecticut in becoming a hub for the U.S. East Coast OSW industry. The State is actively developing supply chain databases, creating workforce-training programs, and building on existing programs in place to incentivize existing companies to expand, as well as to attract new businesses to bring their operations to the State.

With all the assets and programs the State has in place, this Offshore Wind Strategic Study is intended to summarize where the OSW industry is now in 2021, where it is headed through 2030 and 2050, and provide a roadmap that the State may potentially want to take to develop and work with the various industry players as it expands and provides clean renewable energy, along with jobs and economic benefits to the State and region.

[6] https://sunrisewindny.com/ and https://southforkwind.com/

2. Offshore Wind Industry Market Assessment

As discussed throughout this Offshore Wind Strategic Study prepared by the Chamber, the OSW industry is posed for taking off. However, the last several years have seen many challenges for the offshore wind industry ranging from the demise of the Cape Wind project to the previous administration's reticence to move the BOEM permitting process forward. As such, there is a certain level of fatigue associated with the OSW resulting from years of thus-far, unfilled promises of this multi-billion-dollar industry taking off. The purpose of this section of the Chamber's Offshore Wind Strategic Study is to provide an assessment of the current offshore wind marketplace on a state-by-state basis to provide clarity and confidence that the offshore wind marketplace is here, will continue to grow and is well worth investing in by all the players in the marketplace.

2.1. Current Market Conditions

This section of the report provides a state-by-state assessment of the current conditions of the East Coast offshore wind marketplace.

2.1.1. Connecticut

The State has two active offshore wind projects in development; Revolution Wind, being developed by Ørsted and Eversource, and Park City Wind, being developed by Avangrid Renewables. Revolution Wind is a 704 MW project shared with Rhode Island, with the deployment and marshalling to be based out of New London at State Pier. Park City Wind is an 804 MW project with a base of operations to be developed in Bridgeport. Beyond those two projects there is approximately 1,196 MW of unprocured yet authorized offshore wind generation that the State will be soliciting. The next round of procurements is projected to occur in 2023.

The procurements within the State are managed by Department of Energy and Environmental Protection (DEEP) while the economic development aspects of a project deployment are managed by the Department of Economic and Community Development (DECD). The Connecticut Port Authority manages the State Pier facility and is the State's lead agency on dredging and managing the State's deep-water ports, including Bridgeport and the State Pier.

2.1.1.1. East Coast Region

Except for some potential floating wind projects off the coast of California and Hawaii, the U.S. OSW market is currently predominantly centered around the Atlantic Coast. From North Carolina up through Maine, there are 16 active offshore wind leases (including Vineyard Wind 1), as well as U.S. Bureau of Ocean Energy Management (BOEM) call areas being proposed. With over 40 gigawatts (GW) of offshore wind projects already in the queue, 30 GW of projects by 2030 and an additional estimated 70 GW of additional projects by 2050,[7] the OSW industry is poised to take off up and down the U.S. East Coast.

Each state handles their OSW energy procurement and deployment differently, as summarized below:

1. Maine - Through the Maine Offshore Wind Initiative, launched in June 2019 by Governor Janet Mills, Maine is exploring opportunities for thoughtful development of offshore wind energy in the Gulf of Maine and determine how to best position Maine to benefit from the industry.

[7] US DOE Report: Offshore Wind Market Report: 2021 Edition

Due to the depth-to-water and geologic conditions off its shore, Maine represents the first-mover, East Coast floating wind type foundations, both in terms of research and development opportunities.

On October 1, 2021, Maine's Governor's Energy Office (GEO) submitted BOEM to lease a 15.2-square-mile area nearly 30 miles offshore in the Gulf of Maine for the nation's first floating offshore wind research site in federal waters. With this project, the State hopes to deploy a small-scale research array of 12 or fewer WTGs on innovative floating hulls designed at the University of Maine. This project will advance UMaine's patented technology and will foster leading research into how floating offshore wind interacts with Maine's marine environment, fishing industry, shipping, and navigation routes, and more. Maine law (P.L. 2010, chapter 615) implemented the recommendations of former Governor John Baldacci's Ocean Energy Task Force (OETF), established a state goal to develop at least 3,000 MW of offshore wind energy by 2020, and at least 5,000 MW of offshore wind energy by 2030.

2. Massachusetts – The offshore wind program is managed by a quasi-public state agency known the Massachusetts Clean Energy Center (MassCEC). MassCEC handles all aspects of the state's clean energy programs including residential solar, business energy efficiency retrofits, but OSW is a defined subset of their jurisdiction.

   MassCEC supports OSW industry development, while electrical utilities and MA Division of Energy Resources manages the state's energy procurements, with 1.6 GW already procured, and a plan for another 4.0 GW in the future out to 2040. Massachusetts is planning on holding annual procurements, including the next round of energy procurement solicitations issued to developers at the end of the Summer 2021 and expected to be awarded in the winter 2021/2022.

   MassCEC has several assets in place that it uses to support OSW-related activities, including the wind blade testing center in Charlestown, MA, and the New Bedford Marine Commerce Terminal (NBMCT) located in New Bedford, the first-in-the-nation purpose-built offshore wind marshalling facility. Other programs and activities that MassCEC performs include managing a supply chain database, conducting stakeholder engagement events, sponsoring wildlife and fisheries surveys, providing metocean data, performing ports and infrastructure assessments, workforce assessments, transmission planning and funding research and participating in consortiums such as the National Offshore Wind Research and Development Consortium (NOWRD).

3. New Jersey- OSW in New Jersey is managed by the state's Board of Public Utilities (BPU) which manages their procurements, performs stakeholder engagement, and provides training resources for the industry.

   New Jersey has a target of 7.5 GW of OSW energy by 2035 and recently had a solicitation and awarded two projects in June 2021 for an additional 2.66 GW of capacity to expand their procured capacity to 3.7 GW, getting them almost halfway towards their target. These procurements also included various local content/net economic benefit requirements that will include the development of a nacelle assembly facility in Paulsboro, NJ, and the development of a NJ OSW marshaling and manufacturing port located in Salem County.

New Jersey just recently updated is solicitation timeline for the remaining 3.7 GW of Capacity it has committed to, with its Round 3 award expected in Q2 2023, Round 4 in Q1 2025, and Round 5 in Q1 2027[8].

4. New York – The New York State Energy Research and Development Agency (NYSERDA) manages OSW for the state and is a very active agency in the offshore wind market space.

   New York committed to 9.0 GW of OSW energy by 2035, and recently provisionally awarded another 2.49 GW of energy for two projects, bringing the state's total to five projects of over 4.3 GW in active development. This results in 2.21 GW of OSW-derived energy which New York will issue solicitations against to meet their goal of 9 GW of OSW energy by 2035

   NYSERDA's stated mission is to maximize cost-effectiveness of offshore wind, maintain economic vitality of all ocean users, maximize economic opportunity for New York State, cultivate an offshore wind innovation ecosystem, create opportunities for transparent stakeholder engagement, and foster long-term sustainability of the industry. This will be accomplished through grants and programs supporting supply chain development, actively participating in trade groups such as the American Clean Power Association and the Business Network for Offshore Wind and supporting innovation development through research groups such as NOWRD. It is fully anticipated that as BOEM opens up additional lease areas in the New York Bight, New York will increase their levels of solicitations.

5. North Carolina – The state recently upped its commitment to OSW from 2.8 GW by 2030 to 8.0 GW by 2040. The state has a Clean Energy Technology Center run through North Carolina State University. This entity supports the renewable energy industry through education, technical assistance, technology demonstration, equipment testing, policy analysis, site assessments, workforce development, and economic development.

   Since the beginning of 2021, North Carolina has been actively marketing itself and trying to develop and promote Radio Island in Morehead City as a hub for OSW staging and manufacturing.

   North Carolina, along with Virginia and Maryland, have established the Southeast and Mid-Atlantic Regional Transformative Partnership for Offshore Wind Energy Resources (SMART-POWER) to "*promote, develop, and expand offshore wind energy generation and the accompanying industry supply chain and workforce*" in the region.

6. Rhode Island – Rhode Island has the claim to fame of being the home of the first offshore wind project installed in state waters with the Block Island Wind farm, a five turbine, 30 MW project located in state waters off the coast of Block Island. OSW is managed through the state's Office

[8] New Jersey Offshore Wind Solicitations | NJ OCE Web Site (njcleanenergy.com)

of Energy Resources; however, the most active agency in OSW is Rhode Island Commerce, which manages offshorewindri.com and is actively developing a supply chain database, promoting the state's workforce, and promoting the infrastructure and assets organic to the state.

As noted above, Rhode Island has procured 400 MW of the Revolution Wind project and has plans for procuring another 600 MW in the near future, although there have been no recent announcements by the state indicating the implementation schedule for the next solicitation.

7. Virginia – In Virginia, OSW is managed by the Department of Mines, Minerals and Energy (DMME)[9] and they were an early adopter in preparing the state for OSW, conducting a ports and infrastructure assessment back in 2015. The State recently announced plans to procure 5.2 GW of OSW and Dominion Energy is looking to advance a 2.6 GW OSW project[10]. It should be noted that Virginia is a different structure from Connecticut, as Dominion Energy is the regulated utility and therefore is not subject to a *typical* competitive process.

   Virginia is currently a leader in OSW in the Southeast and is actively promoting projects, pushing forward workforce development initiatives, promoting/developing its supply chain, and supporting innovation research and development. Governor Northam recently announced that the Port of Virginia has reached an agreement with Dominion Energy Inc. to lease 72 acres of the Portsmouth Marine Terminal[11].

2.2. Anticipated Market Conditions

It is crucial for the offshore wind industry and U.S. states to provide confidence in the marketplace that there will be active projects both in development and operations for decades to come. As such, this section of the report provides anticipated market conditions both through the near term (i.e., 2035) and the far term (i.e., through 2050).

2.2.1. Projections through 2035

The short-term forecast for the OSW industry is clearer than it has ever been in the U.S. President Biden's administration has set an ambitious goal of deploying 30 GW of offshore wind capacity to be installed by the year 2030.[12] There are currently 16 projects in the Construction and Operations (COP) stage of planning and permitting with BOEM[13].

The OSW industry is a rapidly maturing energy sector that is increasingly being seen as a major contributor of clean, low-carbon electricity supply in the U.S. From Maine through the Carolinas, the Atlantic coastline is where the industry is set to take off with its dense population centers requiring electrical production, good reliable wind resources, and relatively shallow coastal waters. By its nature,

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[9] Recently, Virginia also has the Virginia Offshore Wind Development Authority (VOWDA) to manage OSW projects in the state.

[10] Dominion Energy Submits Application for Coastal Virginia Offshore Wind with Virginia State Corporation Commission - Nov 5, 2021

[11] https://www.virginiabusiness.com/article/dominion-energy-and-port-of-va-reach-lease-agreement-for-offshore-wind-project/?__cf_chl_managed_tk__=pmd_eCXe3FEAKNnkLIw3H5o7b_FJGwq1CG9gN63BsPfUT_0-1630054333-0-gqNtZGzNA2WjcnBszQi9

[12] FACT SHEET: Biden Administration Jumpstarts Offshore Wind Energy Projects to Create Jobs | The White House

[13] State Activities | Bureau of Ocean Energy Management (boem.gov)

offshore wind requires significant coastal infrastructure for manufacturing, staging and construction, and operation of the wind farms. This level of port-development will require significant investments because offshore wind development demands a highly specific and unique set of requirements for its port infrastructure than do other traditional shipping or development sectors.

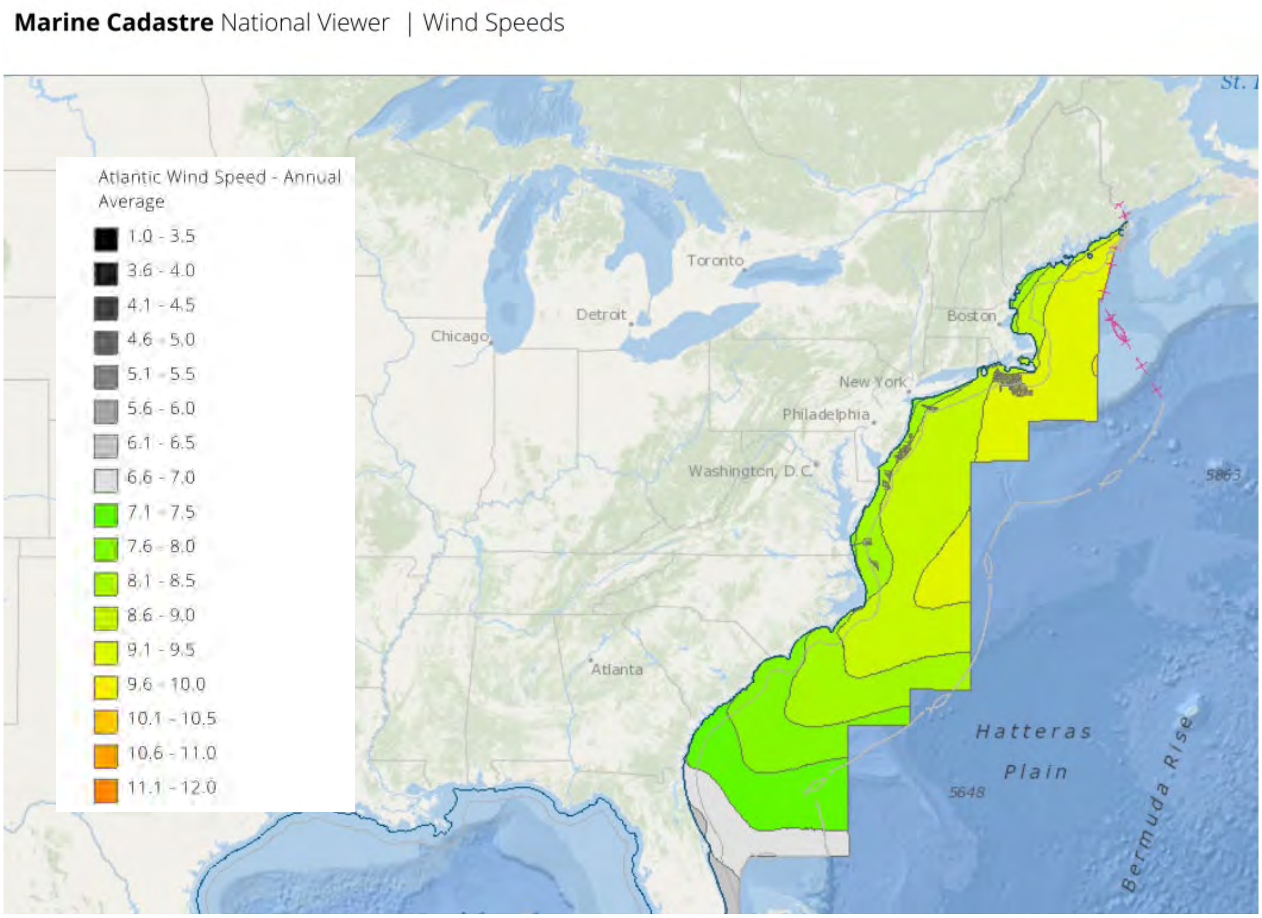

Figure 1 – Wind Speeds in the Atlantic

The European OSW Market started over 30 years ago with the Vindeby Wind Farm located off the coast of Denmark. In the subsequent 30 years, Europe has installed approximately 25 GW of OSW capacity, and with that track record, has developed a robust set of experiences learned over the development cycle of numerous projects in multiple locations. The U.S. market is still in a nascent stage with the first utility-scale offshore wind project set to be deployed by Vineyard Wind starting in 2022. Nonetheless, the U.S. OSW market has significant ambitions, with states from North Carolina to Maine having set significant OSW targets, with over 35 GW of offshore wind capacity projected or in development just through 2035 and with additional energy solicitations on the horizon, particularly as floating-foundation turbine technology advances which will up opportunities in deeper waters from Maine to the Gulf of Mexico to the Pacific Coast.

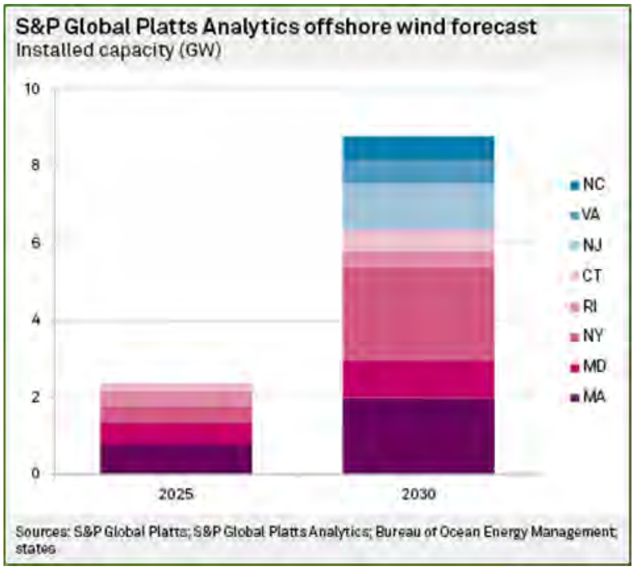

Figure 2 – Offshore Wind Forecast from S&P Global Platts

Major financial predictive indices have joined the industry in forecasting unprecedented growth based on the projects currently in process and/or selected for development. Projections based on current projects already started indicate 10 GW of installed capacity along the U.S. East Coast by 2030 (see graph adjacent by S&P Global - Platts Analytics, 2019). We believe this estimate is conservative and dated, as research into state commitments and development projects conducted by the Team as part of this work indicates that even the current presidential administration's ambition of 30 GW by 2030 is relatively conservative.

The first-mover projects will be utilizing materials and components manufactured outside the U.S., mostly from Europe. As more projects enter the development pipeline, there will be more opportunities available and action needed to develop the U.S. manufacturing supply chain for OSW turbines and balance-of-plant (BoP – includes detailed infrastructure design and supply of all parts of the wind farm except the turbines themselves, including tower, foundations, buildings, electrical systems between turbine and the onshore demarcation point between the wind farm and the on-shore distribution grid). As this market matures and with the rapid growth anticipated, it is reasonable to predict that the U.S. (especially for Connecticut as discussed later in this report) manufacturing capabilities could be in place by in the latter part of the 2020s, although State manufacturers are fully capable of producing subcomponents much sooner). The following provides the primary mechanisms that will drive this schedule:

- The capacity of the existing global supply chain, which in Europe is already facing component-output capacity challenges;
- Transportation and shipping costs from the European manufacturers;
- Local content requirements from U.S. state procurements; and,
- The annual demand from U.S. wind farms being developed.

There are 19 BOEM lease areas along the Atlantic Coast, with 16 in the federal permitting queue and these represent over 1,700,000 acres of ocean space on the outer continental shelf and BOEM is planning on developing and leasing new WEAs in the next four years[14].

[14] OSW Proposed Leasing Schedule (boem.gov)

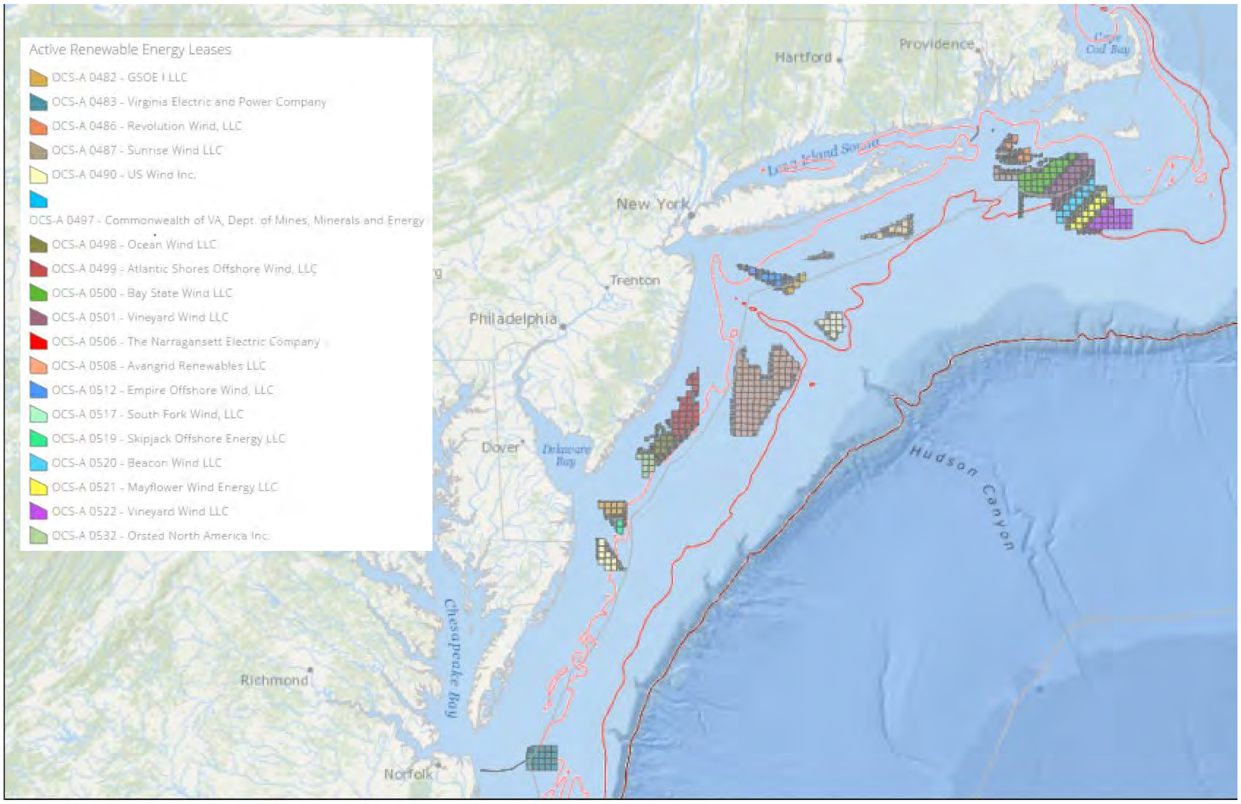

Figure 3 – BOEM chart showing Active Wind Energy Lease Areas

New BOEM Lease Sale activities are being driven by the fact that the majority of East Coast states have made significant commitments or are exploring options to purchase OSW capacity and electricity for numerous reasons, the majority of which involve soliciting clean, reliable carbon-free energy sources to support their specific state decarbonization goals. The BOEM outer continental leasing program must keep up with demand to keep the U.S. OSW marketplace active.

A major challenge being experienced by OSW practitioners is the extremely rapid pace of activities in the offshore wind marketplace. Developers, OEMs, States, BOEM, etc., are making nearly weekly announcements regarding new projects, technologies, etc., all of which makes peer-reviewed development schedules out-of-date. To illustrate this point, the figures below were accurate as of August 2021. In a sense, *this is a good problem to have*, as the OSW industry continues to grow which will result in more opportunities for Connecticut.

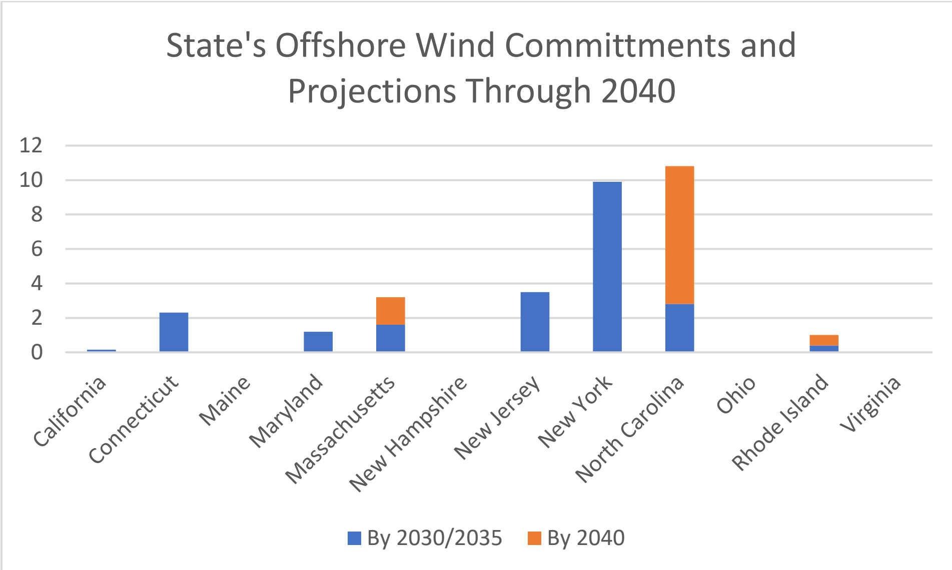

Figure 4 – State's Offshore Wind Commitments through 2040, as of August 2021

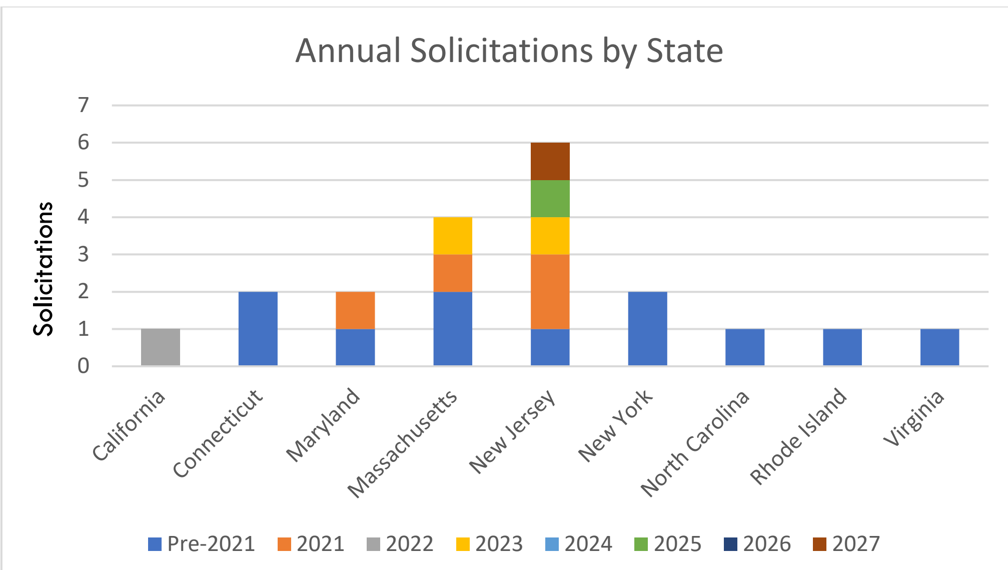

Figure 5 Annual Solicitations that have occurred or are scheduled to occur, by State, as of August 2021

2.2.2. Projections through 2050

Up until recently, projections for the U.S. OSW industry have only been carried through 2035, which is only 14 years in front of us. However, with the recent momentum that the industry has achieved, more states are projecting out further and there is more clarity on the long-term viability of the offshore industry – this is very important as it will give the industry players with the confidence in the long-term nature of the U.S. marketplace. Based on our review of commitments, policy statements, and planning documents, we are showing a projection based on state commitments and authorizations as of August 2021 of up to 65 GW of offshore wind-derived energy in the U.S. through 2050, that would represent a doubling of capacity from the current 2030 goal of 30 GW, and that was before the Biden Administration's goal of 110 GW as of 2050.

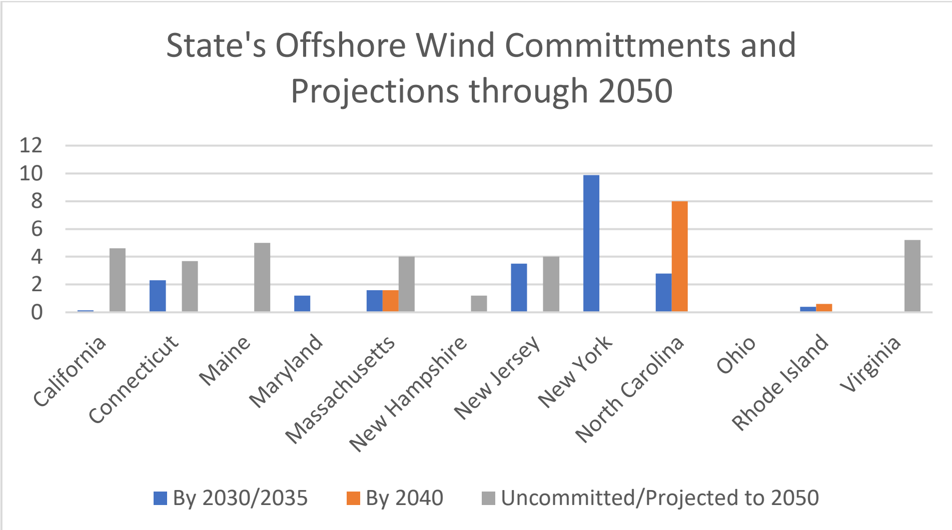

Figure 6 – State's Offshore Wind Commitments through 2050, as of August 2021

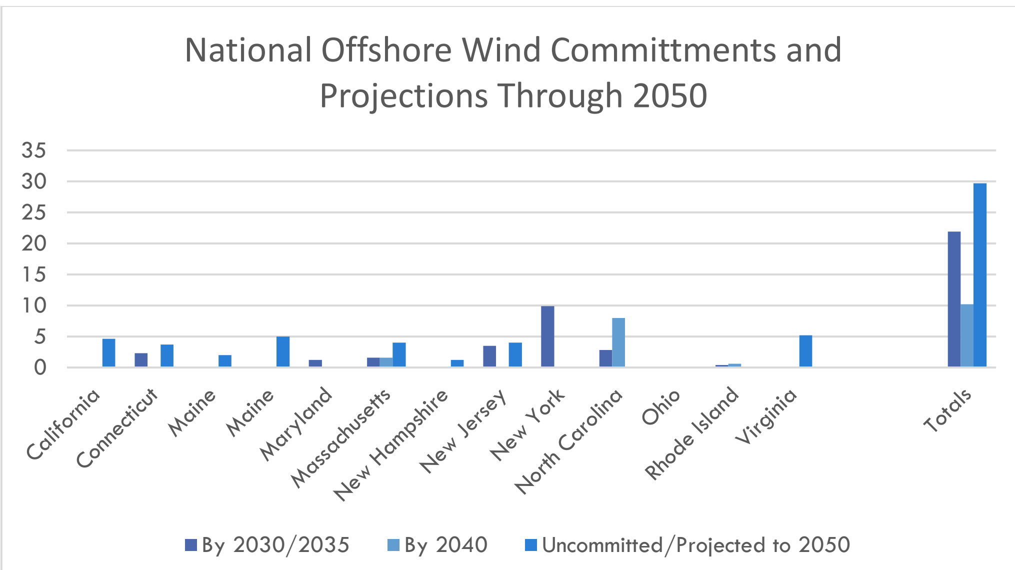

Figure 7 – National Offshore Wind Commitments through 2050, as of August 2021

In addition to MME's analysis, the US Department of Energy (DOE) released in 2015 a report titled *"Wind Vision: A New Era for Wind Power in the United States.*[15]" The report was updated in 2017, and as part of the Wind Vision program, the DOE has developed an interactive study scenario viewer[16] that allows for modeling different scenarios for both generation and capacity. Under the offshore wind technology model, they show between 84 and 87 GW of OSW capacity nationwide, encompassing the Atlantic and Pacific coasts, as well as the Gulf of Mexico. In a recently published paper, the U.S. DOE estimated that there would be 110 GW of OSW in the U.S. by 2050.[17]

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[15] Wind Vision | Department of Energy
[16] Wind Vision Scenario Viewer (openei.org)
[17] https://www.energy.gov/eere/wind/wind-market-reports-2021-edition.

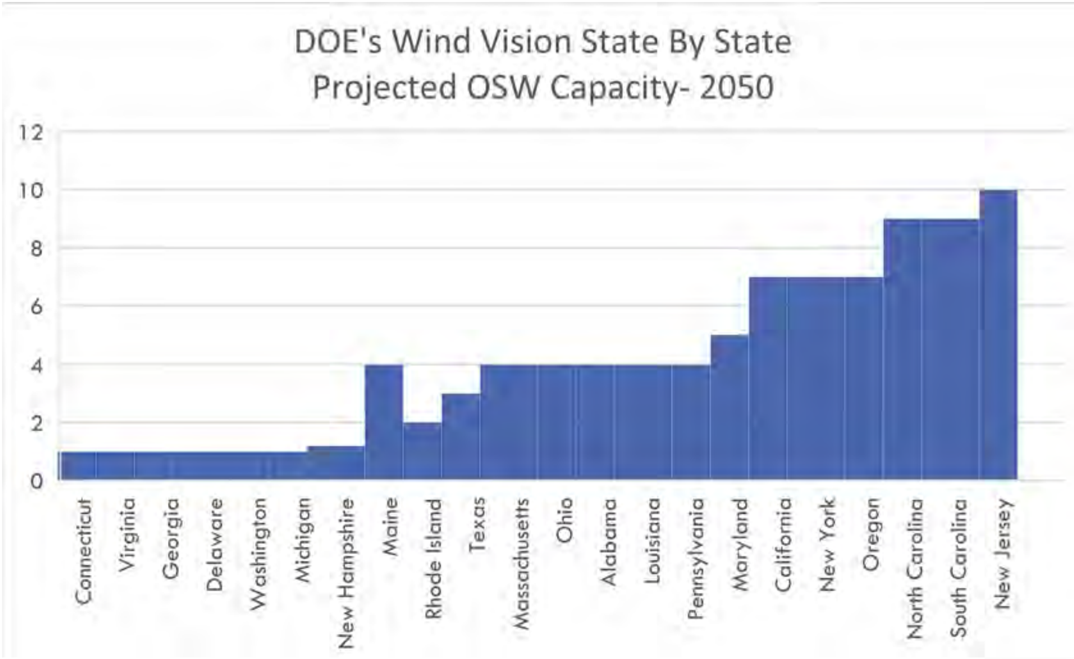


Figure 8- Wind Vision Project Capacity – State by State

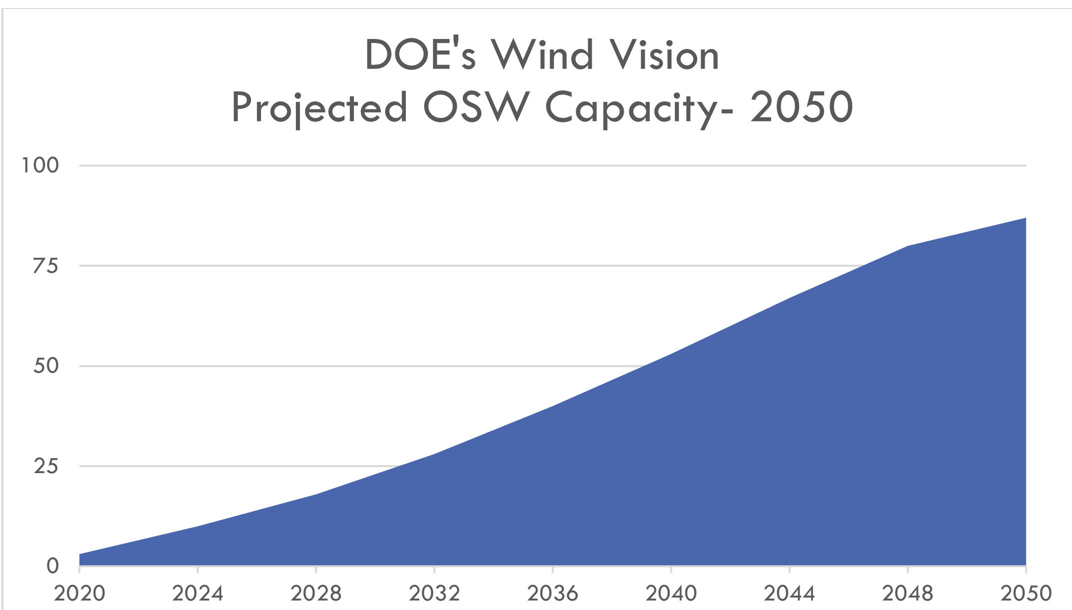


Figure 9 – Wind Vision Projected Capacity to 2050

2.3. Connecticut Supply Chain Market Opportunities

Based on a large number of market indicators, there is a significant emerging market for offshore wind along the U.S. East Coast, with the Northeast from New Jersey to Massachusetts at the forefront of development and activities. For over a decade, there have been several operations and entities from Europe that have been working to build a pipeline of projects in the U.S. that can support the development of a local OSW supply chain. While the U.S. model is expected to have differences from the European strategy, the OSW industry is setting itself up to have a comprehensive U.S. supply chain over the next 10-to-15 years. The U.S. market is closely linked with the European offshore wind markets, and developers and project owners can use this developed expertise to service the addressable markets. While there is an understandable tendency for the U.S. market to follow the European approach to offshore wind development, changes in policy, supply chain development, and port and vessel availability are likely to cause the U.S. to develop models independent and different from Europe. As an example, Jones Act restrictions, available port capacity, as well as overhead height (air gap) restrictions and vessel uncertainty will likely lead to a feeder barge solution for U.S. offshore project installation. As was demonstrated in the recently awarded leases in New Jersey in which the bids included nacelle assembly in the state, local content/net economic benefit requirements are dictating developers' partner with OEMs to build the U.S. supply chain hand-in-hand with their projects. The table below provides a summary of existing, planned or committed supply chain manufacturing activities within the region:

Item	Location	Sponsor
Tower Manufacturing	Albany, NY	Joint Venture – Marmen and Welcon, sponsored by Equinor
Foundations- Advanced Fabrication and Assembly Plant	Providence, RI	Ørsted and Eversource
Monopiles Manufacturing	Paulsboro, NJ	EEW
Nacelle Assembly	Paulsboro, NJ	Vestas
Blade Manufacturing	Portsmouth, VA	Siemens Gamesa
Advanced Foundation Components	Port of Coeymans, NY	Ørsted, Eversource and Riggs Distler & Company, Inc.
Offshore Substation	Ingleside, TX	Ørsted, Eversource and Kiewit Offshore Services, LTD.

Table 1 – Supply Chain Manufacturing in the Region, as of October 2021

Although it is not in the immediate region, Ørsted and Eversource recently announced a partnership with Kiewit to fabricate offshore wind substations in Texas, which will be used for Ørsted's South Fork project will advance the U.S. supply chain as a whole

As the U.S. industry pushes to create more manufacturing and develop a local supply chain, it will be competing not only with the existing European supply chain, but with the ever-growing Chinese and Asian market. In 2019 alone, there were 17 GW of offshore wind installed worldwide, with 88% of that coming from Asia[18], and there is a projection of 74 GW of capacity to be installed in Asia through 2025. Chinese wind turbine manufacturer MingYang recently announced that it has developed a 16 MW turbine[19], the highest capacity WTG developed to date.

[18] The Untapped Potential in Asian Offshore Wind Power – BRINK – Conversations and Insights on Global Business (brinknews.com)
[19] MingYang Launches 16 MW Offshore Wind Turbine | Offshore Wind

3. Offshore Wind Industry Needs Assessment

3.1. Surveys and Interviews with OSW Industry Leaders

After years of sputtering and stalling, the current OSW industry is finally picking up steam and rapidly developing. To better understand how the market is developing, the MME team coordinated and interviewed several of our contacts from across the industry. These industry representatives provided invaluable insight into a broad range of conditions that will affect the OSW industry. MME interviewed and surveyed representatives from the following industry entities:

- OSW Developers (Ørsted, Eversource, Vineyard Wind and Avangrid)
- Port Operators (Connecticut Port Authority, MassCEC and Waterson Terminals)
- Original Equipment Manufacturers (General Electric)
- Supply Chain entities (Crowley and Mohawk Northeast [NE])
- Vessel Operators (Cross Sound Ferry)

These interviews complemented our existing industry knowledge, the webinars we presented or attended, as well as industry journals and articles, to help us develop our list of desirability characteristics and opportunities that exist within Connecticut.

3.2. Market-based Supply Chain Desirability Characteristics

As with any fully integrated industry, the offshore wind market which is currently developing off the East Coast of the U.S. will be highly dependent upon a large and, currently, mostly international-based supply chain to support the buildout of over 60 GW of clean, renewable energy by 2050. The OSW supply chain is currently, and will in the future, be comprised of a wide-range of manufacturing firms with a wide-range of capabilities, capacities, and locations (both domestic and international).

The major challenges with both evaluating and attracting the OSW supply chain to the State, and to the Country as a whole, is related the nascent nature of the U.S. offshore wind marketplace. With the recent approval of the first commercial scale offshore wind farm off Massachusetts by BOEM, it is both hoped and anticipated that the flood gates will open to allow for planned development of 16 U.S. offshore wind farms which are currently in the permitting queue. The initial U.S. first-mover offshore wind projects will likely be constructed with components manufactured overseas, primarily in Europe. As the market matures over the next few years, there should be more and more local content in the OSW supply chain and the OEMs and supply chain manufacturing entities will need to initiate operations to the U.S., either due to state-driven local content requirements and/or by reducing risks in the supply chain logistical train, as discussed below.

For this section of the Chamber's Offshore Wind Strategic Study, MME is providing a general discussion of the offshore wind supply chain and the market desirability characteristics that Connecticut has to offer the supply chain to attract them to the State.

The products/components for the industry can be divided up into the following categories:

- **Tier 1 Components**: These include completed primary-level components which are ready for installation by a developer (or developer-retained contractor) such as blades, nacelles, foundation elements, transition pieces, towers, export cables, inter-array cables, etc. The manufacturers of these components are usually under the purview of OEMs such as GE, Seatower, EEW, JDR Cable, etc. and not the offshore wind developers/installation contractors themselves. OEMs typically provide completed component sets to developers for installation out in their associated offshore wind farms. These Tier 1 components represent the largest-scale elements that require direct access to heavy-lift maritime vessels for delivery to staging and/or construction base/marshalling ports. As these components are preassembled at highly specialized construction base/marshalling ports for shipment out to the offshore wind farms, their manufacturing facilities are often located adjacent to developer's marshaling ports.

- **Tiers 2, 3 and 4 Components**: These are typically sub-components such as specialized bearings, electrical components, transmission components, gears, secondary steel, nuts, bolts, etc. Their manufacturing pose differing infrastructure requirements and are not necessarily tied to water-side port facilities, or to port-infrastructure restrictions (e.g., air-gap restrictions, robust quaysides, etc.), as are the Tier 1 manufacturing ports and/or construction base/marshalling ports. Rather, this scale of OSW manufacturing could be accommodated across all of Connecticut, not just along the State's shorelines. Depending upon the scale of the items manufactured, the completed sub-components could be of a small-enough scale for shipment by intermodal means such as rail, road and/or smaller maritime vessels. The large number of existing Connecticut firms capable of manufacturing of these smaller-scale components are a significant strength of the State, with its highly trained work force, experience in all levels of manufacturing (including maritime and aerospace firms) and existing manufacturing/fabrication assets currently organic to the State.

3.2.1. Opportunities for a Connecticut OSW Supply Chain

There are three primary opportunities for Connecticut to become relevant in the offshore wind marketplace, including the following:

Construction, Marshalling and Tier 1 Component Manufacturing

As discussed in Section 4 below, construction base/marshalling ports are centralized facilities that are located close to their associated offshore wind farms(s) and that support the actual construction of an OSW farm. Completed major components (e.g., blades, nacelles, towers, and foundations) are received, pre-assembled as required at the port and shipped out to the OSW site for installation. Construction base/marshalling ports are highly specialized facilities and require very robust infrastructure as discussed in detail below.

Construction base/marshalling ports are the large facilities that are often identified as the best port type to attract by states desirous to enter the OSW marketplace. For Connecticut, the New London State Pier and three Bridgeport properties are the primary locations in the State for use in these types of operations.

In Europe, manufacturers (i.e., OEMs) of Tier 1 components often share port space, or at a minimum, directly adjacent spaces, with developers/installation contractors at a construction base/marshalling port. This use of "*mega ports*" wherein one large facility can support both marshaling and Tier 1-component manufacturing operations that is prevalent across Europe is not readily replicable in the Northeast U.S. due to lack of sufficiently large and available ports.

It should be noted that the manufacturing of Tier 1 components will likely have their own highly specialized infrastructure requirements. For example, MME understands that one manufacturer of

OSW export cables requires the construction of a 1,200-foot-long building to support their manufacturing process. Another cable manufacturer has indicated that they require a certain amount of vertical space (whether up into the air space or down into the sub-grade) to support their manufacturing operations. Once completed, the cables are strung onto large "bobbins" where they are shipped to a port where they are loaded on to highly specialized cable-installation vessels (CIVs) for installation from the offshore wind farm and land-side interconnection point.

Tier 2 through 4 Component New Manufacturing Facilities

This category represents an opportunity to attract currently non-U.S.-based OSW manufacturers to Connecticut to start up new operations. It has been generally reported in the OSW industry that many of the European-based manufacturing facilities are reaching their maximum manufacturing capacities and their owners and investors are in the process of evaluating alternatives[20], including expanding their existing European facilities, or taking the leap and initiating new operations in the U.S., both to service the developing U.S. market and to provide components to the international market. Further, as Tier 2 through 4 components are generally much smaller in scale than Tier 1 components, they can be shipped via intermodal assets and their associated ports/locations are not as constrained with respect to port-infrastructure requirements (e.g., air-gap restrictions, robust quay sides, etc.) as Tier 1 manufacturing ports and construction base ports.

Manufacturing these components in the U.S. has several advantages:

- It allows OEMs, and by extension developers, to show commitment to anchoring operations in the U.S., thereby increasing the local content, whether the individual state's power purchase agreements (PPAs) or offshore wind renewable energy certificates (ORECs) require such local content.
- It lowers the risk of supply chain disruptions to service the U.S.-based offshore wind market by lowering vessel/component transit times and risks associated with shipment delays due to inclement weather conditions. As such, it lowers the overall risks associated with the supply chain and results in a more robust *bankable and insurable* supply chain logistics model.
- It provides stabilization for the international offshore wind marketplace by diversifying the supply chain. There are currently over 307 GW[21] of planned offshore wind projects in various stages of planning, design, permitting and construction across the globe which will require a truly global offshore wind supply chain which the Connecticut is fully capable of entering into and being competitive.

  In some cases, these types of manufacturing facilities could also manufacture products to supply sectors other than OSW. For instance, a cable-manufacturing (a Tier 1 work-flow component) facility could easily provide cables for other, non-OSW uses.

Connecticut Opportunity: There can be a significant number of jobs and tax ratables associated with the use of Connecticut water-side facilities located upstream of bridges, as well as non-waterfront properties for smaller components which accessible to the State's robust intermodal transportation system. This would result in a *One Connecticut* supply chain which would utilize State assets from across its geography and not be limited to shoreline areas of the State.

[21] Offshore Wind Market Report: 2021 Edition (energy.gov) Page x

Tier 2 through 4 Component Manufacturing at Existing Facilities

One of Connecticut's greatest strengths in the U.S. OSW marketplace lies in its existing manufacturing and fabrication assets. The primary business lines for many State manufacturers are already well established including their associated supply chains. Therefore, initial investments into the OSW industry would represent a low-risk growth strategy for State firms as these new work-flow components would not represent their primary, current business lines. Simple market economics will ensure that early Connecticut entrants into the offshore wind market will grow and profit (resulting in more jobs) as the related supply chains develop. For instance:

- The is a well-developed Connecticut-based maritime supply chain predominantly revolving around General Dynamic's Electric Boat (EB) manufacturing facility located on the Thames River in Groton. This supply chain is incredibly diverse and includes welders, shipwrights, fitters, steel manufacturing highest-end electronics design and manufacturing, marine architects, engineers, quality assurance (QA) inspectors and scientists, just to name a few. Also, it appears that EB is here to stay with contracts reportedly in place to manufacture several nuclear submarines over the next coming years (i.e., two Virginia-class attack boats and one Columbia-class[22] boomer [nuclear missile] boat) per year. Electric Boat expects to increase its workforce from 17,000 today to 20,000 by 2030.

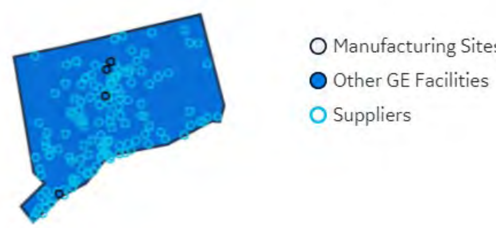


Figure 10 Map of GE CT assets

- According to aerospace manufacturing firm General Electric (GE)[23], as of December 2020, they directly employ 1,080 residents of Connecticut and utilize the services of 410 suppliers. Many of these firms are located along what GE refers to as the *Aerospace Manufacturing Corridor* centered along I-91.
- As an example of a more general maritime business, Mohawk NE is a New London/Groton-based company that provides both maritime services (e.g., barges, cranes, pile drivers, amour-stone placement etc.) to the local market, as well as manufacturing/fabrication services of metal components as part of the work they conduct for the Connecticut Department of Transportation (CT DOT), EB, U.S. Department of Defense (DOD) and the U.S. Army Corps of Engineers (ACE) for projects located in Connecticut, New York, Massachusetts and Rhode Island.

Based upon the incredible State asset of highly skilled and experienced manufacturing entities, Connecticut is one of the states in the U.S. most prepared to immediately initiate operations to supply the OSW lower-tier manufacturing requirements, even those associated with awarded first-mover projects.

[22] The Day - Electric Boat secures $9.47 billion Navy contract to build Columbia submarines - News from southeastern Connecticut

[23] (https://www.ge.com/news/statesdata-display?stateid=CT)

Existing manufacturing entity strengths directly relevant to the offshore wind industry include, but are clearly not limited to, the following:

- **Employee Safety**: Many of the State's prime non-OSW OEMs such as EB, GE, Sikorsky Aircraft, etc., have employee safety as one of their number one goals. Their contracts for manufacturing services to OEMs include stringent, employee-safety requirements. OEM contractual flow-down requirements ensures that this c*ulture of safety* is present and practiced throughout the associated supply chains.
- **Skill Level**: There are no higher levels of quality and competent skills required than for aerospace manufacturers. Our country's security and safety of our military personnel depend upon the high-quality components manufactured within the State. As such, Connecticut manufacturing workers must be highly skilled at their jobs as literally millions of lives depend on their work. Similarly, OEMs rely upon the quality of the manufactured components to meet the essential needs of the public.
- **Level of Quality Assurance/Quality Control (QA/QC)**: The majority of the existing OSW developers and OEMs are based in Europe and require that their manufactured components meet European Union (EU) QA/QC standards which many Connecticut manufacturers will not initially be familiar. However, with end-users of their existing products including the nuclear U.S. Navy, aircraft manufacturers, etc., many of the State's manufacturers are ISO 9001 certified and/or are enrolled in rigorous QA/QC programs as required by their end-use customers. Existing State manufacturing entities will therefore quite easily be able to pivot to meet EU QA/QC programs and their associated goals.
- **Readiness/Availability**: Connecticut's manufacturers are already on-line and are producing products. Much of the manufacturing equipment and manufacturing elements - including lathes, mills, shot-blast rooms, laser cutting tools and welding machines - are top-of-the-line, and in many cases, computer controlled with operators and workers that are experienced in their operations. As such, when provided a specification or design, skilled State workers will be able to utilize their organic assets (e.g., machine tools) to manufacture the required OSW components on a cost-effective basis.

  Another related asset of the State's manufacturers is that they are already in business and will be able to quickly pivot their output products to immediately meet the needs of the OSW marketplace. In the event that a particular manufacturer's *book of OSW business* appears to exceed their existing capacity, in-service manufacturers can expand their production facility, rather than needing to start from scratch. As a final strength, Connecticut's existing manufacturing assets already are well integrated with their associated supply chains and intermodal transportation assets.

Connecticut Opportunity: The presence of a mature and highly skilled manufacturing community within the State will be of the utmost importance to Connecticut's entrée into the Offshore Wind supply chain marketplace by being immediately available to address and support procurement requests. This ability to service first-mover projects will cement Connecticut's place in the long-term domestic and international Offshore Wind supply chain.

3.3. Market-based Port Desirability Characteristics

The global offshore wind market is rapidly expanding and evolving and to provide a competitive levelized cost of electricity (LCOE), the components are larger and require specialized port infrastructure to ensure efficient and cost-effective installation strategies. To understand how the port facilities need to be configured and what infrastructure characteristics are needed, it is important to understand the magnitude and weight of the massive components that make up WTGs and BoP.

The current generation turbines are between 12 MW and 15 MW in generating capacity. The cutting-edge GE - Haliade X that is being used for the Vineyard Wind 1 project (i.e., the first commercial scale OSW farm being deployed out of Massachusetts); as well as the Siemens Gamesa SG 11.0-200 DD that will be used on the Revolution Wind project, are massive turbines, with 107-meter (350 foot) blades, over 220 meters (720 feet) in diameter. The image below provides a reference to the size of a turbine, where just one GE Haliade X, laid flat would occupy the same footprint at the new Yankee stadium in New York City.

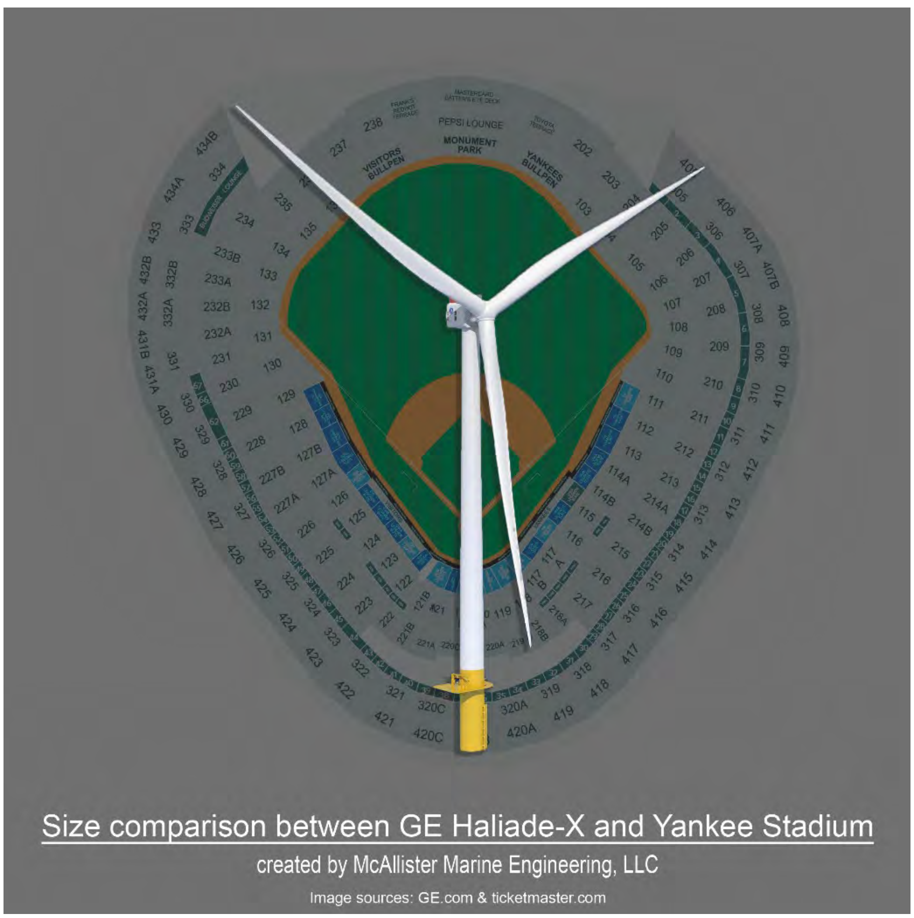


Figure 11 – Size Comparison of OSW Turbine to Yankee Stadium

Not only are these components massive in size, but they are incredibly heavy as well. The nacelle of the GE Haliade-X weighs a massive 675 tons, the equivalent of 18.5 fully loaded tractor trailers as demonstrated in the image below.

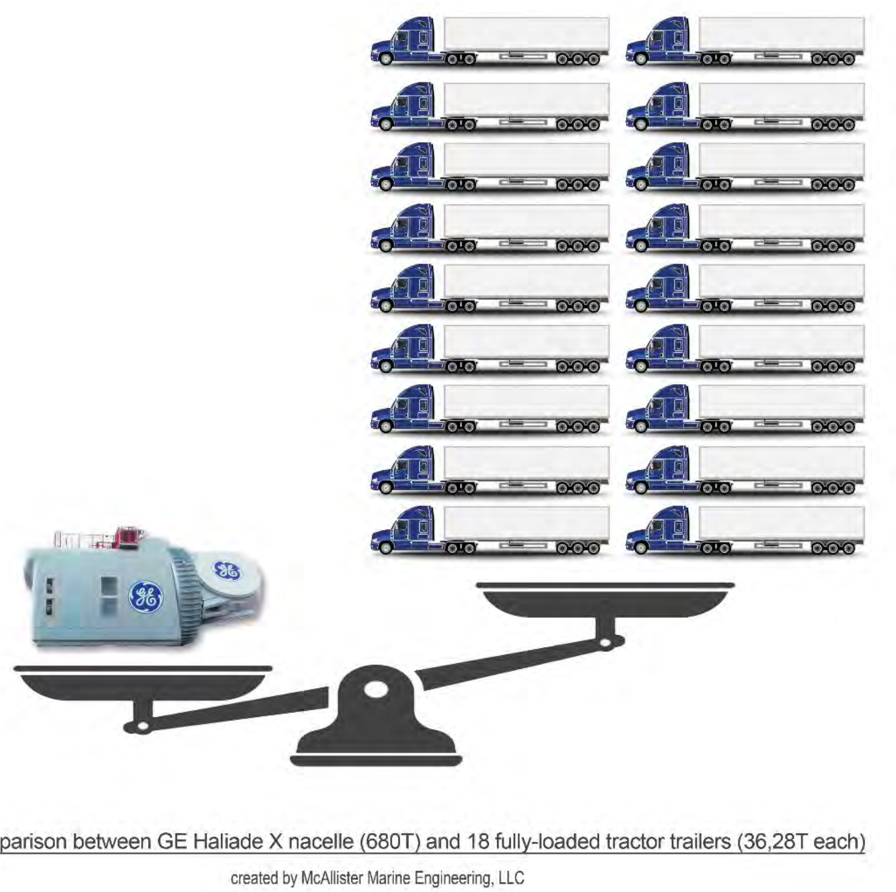


Figure 12 - Weight Comparison of a nacelle and 18 Tractor Trailers

4. Connecticut Ports Assessment for Offshore Wind

This section of the Chamber's Offshore Wind Strategic Study is focused on the port facilities in the State that are currently playing, or could play, a role in the OSW marketplace. Two offshore wind developers are currently engaged in operations at two separate port facilities in the State – Ørsted/Eversource at the New London State Pier, and Avangrid Renewables in Bridgeport. These two developer's activities provide a solid platform for the State from which to launch its local offshore wind industry. This analysis of State port facilities centers around the concept that existing PPAs held between the two existing developers and State utilities provide a stable platform for the initial development of port and logistics construction parameters and the supply chain. Future PPA procurements in the region, including those planned in Connecticut, Rhode Island, Massachusetts, and New York will serve to amplify the early mover status that exists in the State, and lead to the establishment of additional marshalling ports, manufacturing ports, and/or operations and maintenance (O&M) ports.

There are also underutilized waterside facilities within Connecticut ports and harbors: many of these properties have potential to be repurposed to meet the needs of the new OSW industry. They include a former coastal power plant property and former shipyard facilities, and industrial and marine industrial facilities. These facilities have existing infrastructure and other attributes that represent significant opportunities for manufacturing and fabrication, staging and pre-assembly, and the O&M sectors of the OSW supply chain.

Due to their size, weight, and configuration, most all OSW turbine and BOP logistics must transit through ports, and the availability of suitable infrastructure will be critical to the success of the U.S. OSW industry as a whole. Over the life cycle of a wind farm project, the phases of manufacturing and production, assembly and preinstallation, installation, commissioning, O&M, and eventually decommissioning, all require port facilities with specific attributes. Generally, the various port facilities can be grouped into the following primary categories:

- **Construction Base/Marshalling Ports**: These are port facilities when completed, large-scale components are staged, pre-assembled and loaded onto highly specialized vessels, such as jack-up feeder vessels and barges, for delivery and installation at an OSW farm. These port facilities need to be located within approximately 150 miles of the wind farm sites to minimize transit times between the facility and the installation site. The port needs to accommodate the stockpiling of components (approximately 25-to-50% of the total) to allow for a continuous offshore installation process. This requires 30 to 50 or more acres for this type of OSW port facility.
- **Storage Ports**: Due to the lack of U.S.-based manufacturing facilities of the highly specialized OSW components such as blades, nacelles, towers, foundations, cables, etc., it is anticipated that most of these components will be provided by overseas manufacturers/suppliers for the first U.S. projects. Storage ports are facilities in relatively close proximity to an associated construction base/marshalling port that would stage additional components to provide sufficient feed stock to successfully support the OSW installation campaigns. Depending upon the specific components staged, these types of ports will require robust upland areas, as well as strengthened quaysides and deep-water access to allow for the trans-shipment of components to the associated construction base/marshalling port. These infrastructure upgrades, once completed, would make

it more feasible to pivot facility uses to support other portions of the OSW industry as facility needs arise.

- **Manufacturing Ports**: Tier 1 OSW components are so large and heavy that, once fabricated, they will not be transportable by rail or road. Accordingly, components will require transportation from the manufacturer to staging ports, construction base/marshalling ports and eventually out to the wind farm facilities themselves by WTIVs and/or barges. It is anticipated that as the U.S. OSW market continues to grow along the East Coast, manufacturers of OSW components will make investments to initiate manufacturing activities within the U.S. The area required for most OSW manufacturing facilities are approximately 30–to-50 or more acres.

- **Operations and Maintenance Ports**: Once an OSW farm has been constructed, commissioned, and is producing power, marine operations will pivot into an O&M mode. The nominal 25-to-30-year life cycle of an OSW farm will require O&M operations to ensure that a facility will perform at peak capacity and operate in a reliable fashion. O&M activities are typically carried out by two main vessel types: 1) Crew Transfer Vessels (CTVs) which are relatively small and fast vessels which sail out of and return to their O&M base ports daily; and 2) Service Operations Vessels (SOVs) which are larger hotel-style ships which remain on-site for multiple weeks at a time with the crews living onboard. The selection of CTVs or SOVs to provide O&M services is typically a function of distance from the O&M port to the associated OSW farm, with CTVs utilized to support nearer-shore farms, and SOVs for wind farms located farther off the coast. In Europe, O&M ports also often serve as the logistics and operations center for their associated wind farms. The area required for an O&M Port is approximately two-to-five acres.

Figure 13 – Offshore Wind Turbines in Operation

- **Service/Repair Port**: A service port is similar in characteristics to an O&M port, but these facilities have more area for storage and switch-out of large replacement components. A service port can support multiple wind farm projects. The area required for a service port is approximately five-to-20 acres.

To maximize economic development opportunities in Connecticut associated with the emerging OSW industry, the Chamber has included in the work stream for this Strategic Study an assessment of State ports that may be available for use in the OSW industry. The goal of this assessment was to compile relevant information concerning the existing port assets within the State to enable developers, supply chain companies, and other enterprises/interests to make informed decisions on the utilization of local infrastructure in their decision-making processes when selecting sites to manufacture, stage, marshal, and service components for the OSW market in Connecticut.

It should be noted, that due to the preliminary nature of this report, individual property owners were not typically approached by MME or the Chamber. The following discussion of specific properties was solely prepared to illustrate the planning/evaluation process and in no way represents specific property acquisition goals by MME or the Chamber.

The evaluation for this project was built on several other initiatives that have been undertaken by other East Coast states that are actively pursuing attracting the offshore wind supply chain. In 2017, MassCEC released a *Massachusetts Offshore Wind Ports & Infrastructure Assessment* which provided the OSW industry, its associated supply chain, property owners and facility operators, municipalities, and other interested parties with important information on existing port infrastructure at 18 waterfront properties in that state. There were two components of the assessment: (1) an Existing Conditions Assessment, which compiled detailed information concerning the conditions existing at each site; and, (2) an Engineering Assessment that identified reuse scenarios for various OSW port facilities and evaluated the potential redevelopment and improvements that may be necessary or advantageous at each site, produced conceptual design scenarios for those potential improvements, estimated potential costs, and identified the required permitting steps associated with design implementation. The states of New York, Virginia, North Carolina, and Maryland all followed suit and conducted similar assessments of infrastructure assets that could be used within each of those states by the OSW industry.

Generally, following the methodology and approach of these prior reports, the Connecticut OSW ports assessment includes the following components:

1. A description of the port and operational requirements for various anticipated OSW-type operations;

2. A screening level assessment of port facilities 20 acres or greater in area that could have a potential reuse role as a construction base port, manufacturing port, O&M and/or service/repair port; and

3. For the sites that were identified from the screening assessment:

    a. An Existing Conditions Assessment, describing available existing conditions of the sites evaluated, including ownership, current use and historical uses, access and transportation, physical site conditions and facilities, environmental conditions, and existing plans, designs, as-built surveys; and,

    b. An Engineering Assessment, describing how each of the sites might be redeveloped or modified to suit specific OSW uses, consideration of a range of redevelopment activities, and identification of specific OSW port activities which might be suitable for the property. For the redevelopment and reuse scenarios for each site evaluated, estimates of the prospective general costs for redevelopment are provided.[24]

The following were considered in the evaluation of these port sites:

[24] The Redevelopment and Reuse Scenarios presented herein are examples of ways in which the properties could be redeveloped and used by the offshore wind industry and are not intended to suggest that there are not different or alternative ways in which the sites could be redeveloped and used. The scenarios presented are intended to project a generic set of activities that could be undertaken at a given property to prepare it for use as an offshore wind industry asset. It is recognized that each offshore wind port activity has particular requirements for infrastructure. It is expected that the OSW industry will determine what specific modifications would best serve their own needs.

- The continued technological advancements in wind turbine generators (WTGs) which continue to increase in capacity and size and capacity; the largest commercially available currently are in the 10-to-15 MW range.

- Long-term O&M service bases for both SOV and CTV operations. These O&M operations represent long-term employment and economic development opportunities for offshore wind.

- Other potential manufacturing activities such as secondary steel, coating applications, etc.

4.1. Component Logistics and Current Trends in the Industry

To reasonably assess the potential for State port facilities and properties to adjust and adapt to OSW use, the basic component parts of the projected wind farms slated for installation off the East Coast, and the manner in which components are shipped, stored, and used, needs to be understood. A similar effort was performed for MassCEC for the NBMCT by a team of Lloyd's Register, BVG Associates, ONP Management and Hines + Partners. This section uses that analysis and description as a base and has been updated to the current environment and adapted to Connecticut. The following section discusses the types of components that are involved in wind farms and the logistics necessary to support their installation.

4.1.1. Wind Farm Component Analysis – Current Technological Constraints

The installation of OSW farm components is subdivided into top-side and the below-the-water segments.

4.1.2. Nacelle, Hub and Generator Assembly

Turbine sub-components are typically manufactured at a multitude of facilities and then shipped to a property where they are assembled; there is not typically a combined nacelle, hub, and generator manufacturing facility. Rather the assembly of the subcomponents is conducted at one site. Key components are typically *design win* meaning the OEMs construct competitive component designs and the most suitable for the developer's application is selected. As the technology is mostly European led at present, turbines are most likely to be designed and constructed with the European supply chain. The U.S. East Coast market is likely to use European designs that are currently manufactured at facilities located in Europe; however, the Chinese market is also making a significant push to capture more and more of this marketplace share. Due to potential delays associated with an international supply chain, assembly in the U.S. is only likely to be feasible if production of key components is also primarily undertaken in the U.S. once the domestic OSW marketplace takes hold. The minimum viable market-size for a nacelle assembly facility is likely to be one that produces at least 1 GW/year, and ideally one that can produce 2 GW/year, with the investment most likely from the market leader.

The table below depicts the growth of the OSW market with respect to turbine components.

	Industry Start-up Through 2023	**Early Growth Stage 2024-2027**	**Established Industry 2028-**
Turbine Size	10-13 MW	12-15 MW	15-20 MW
Production Rate	< 1 GW/ year or 50-80 turbines/year	~ 2 GW/year or 130-150 turbines/year	> 2 GW/ year or 150 + turbines per year
Supply Chain Status	Most components produced outside U.S.; market not big enough to justify U.S. investment	Towers, blades, and foundation pieces mostly produced in the U. S. Nacelles, hubs and generators still imported for assembly.	Market will support more investment and most major components will be produced and/or assembled in the U.S.

Table 2 - Overview of Industry Turbine Component status.

4.1.3. Tower Production

Towers form part of the turbine scope but are typically outsourced by the turbine OEMs. The supply chain is not complex and tower production can be localized relatively easily. A barrier to investment is that turbine suppliers do not typically award contracts for more than two years. If investors amortize their investment over this period, this is likely to make the towers too expensive.

- *Through2023*: The annual wind farm production rate increases from 0 to about 1 GW. The market is not large enough for a U.S. investment and all tower production is undertaken outside the U.S.
- *2024-2027*: The annual wind farm production rate is approximately 2 GW. The market will support investment by two suppliers with two thirds of towers produced in the U.S. Marmem Welcon is committed to producing towers at the Port of Albany and plans to be operational by the end of 2023.
- *2028-Beyond*: The annual wind farm production rate is more than 2 GW. The market will support investment by two suppliers with two thirds of towers produced in the U.S.

4.1.4. Blade Production

Blades are invariably produced in-house by an OEM (or a subsidiary in the case of GE). The minimum viable size of a facility is likely to be one that produces 1 GW/year. Suppliers typically have a secondary manufacturing site that enables them to respond flexibly to market demand. The supply chain is largely commodity based, and these can be sourced globally with relatively low transport costs.

- *Through 2023*: Blades are typically in the 90 to 110 meter in length range. The annual wind farm production rate increases from 0 to about 1 GW. The market is not sufficient for a U.S. investment and all blade production is undertaken outside the U.S.
- *2024-2027*: Blades are typically in the 90 to 120 meter in length range. The annual wind farm production rate is about 3 GW. The market will support investment by one market leader supplier with half of blades produced in the U.S.
- *2028-2035*: Blades are typically in the 90 to 120 meter in length range. The annual wind farm production rate is about 2 GW. The market will support investment by the top two suppliers covering three-quarters of the market.

4.1.5. Foundation Manufacturer

The foundation manufacturing and installation process is typically separate, preceding the WTG installation. The choice of foundation concept is a design element that developers weigh by factoring in water depth, turbine size, environmental restrictions (such as noise, sea state, vessel logistics, supply chain location and infrastructure) and workforce synergies with existing industrial bases. Monopiles are the primary foundation of choice in Europe, and they continue to be selected for 10 MW+ turbines. Because large monopiles may have masses of 1,500 tons or more, they rely on the use of high-specification vessels for installation (see below). The viability of a U.S. monopile factory would therefore be linked to steel tariffs and the pressure on PPA/OREC prices. Monopile production is a specialist activity and transition piece production are generally undertaken by a different company at a separate site. The two related companies often have established working relationships and bid as a joint venture.

Jacket foundations are typically lighter structures than monopiles for a given wind farm site, but costs of the existing designs are higher due to their associated higher labor content and the slower rate of production. Jackets are typically secured to the seabed using pin piles and that are typically supplied by a separate supplier. Suction bucket jacket foundations are another option that adds fabrication cost but reduces installation noise as the hammering process is replaced by a vacuum pump installation process. Jacket manufacturers may also produce transition pieces and potentially on the same site, which reduces the investment risk.

A third type of fixed-bottom foundations that are currently being considered for the U.S. market are gravity-based structures (GBS) foundations. Most GBS foundations in Europe were used for very early wind farms projects (e.g., in the early 1990s) in water depths less than 10 meters. Since then, commercial OSW projects have considered them, and they have generally had similar costs (supply and installation) as jackets. Concrete batch plants allow for a localized and mobile production, providing rapid local content, as well as enabling decentralized and flexible foundation work. Access and port size limitations are challenging factors as significant amounts of acreage are required to assemble and float these very large GBS components. A barrier to their wider use has been the upfront investment in production facilities. The UK's Blyth Offshore Demonstration Windfarm (EDF) used five GBS foundations in 2018 and was the first European project to use the technology since Kårehamn (E.ON) in 2013. Further, significant dredging of the seabed at the installation location can add to project complexities and costs. The OSW developer Equinor was considering the use of GBS foundations for its Empire Wind project[25] in New York, however it is not clear if they will be using them. It has made an early commitment to enable investment in a factory. The decision is likely to have been influenced by vessel logistics (see below). In addition to the need for a large, local labor force to manufacture GBS foundation's, one of the prime advantages of this technology is that there is little to no acoustical impacts to marine fauna during their installation.

Of late, there has been a high level of interest in the use of OSW floating WTGs. In this technology, one or two top-side components are installed on a floating platform which is then towed out to the installation site. There are various methodologies for securing the floating foundations to the seabed.

[25] Empire Wind – OSW Supply Chain

It is anticipated that floating WTGs will be utilized effectively in deeper water conditions (e.g., greater than 60-to-100 meters[26]) and as well as locations where the sea-floor geology is not amenable for the installation of fixed bottom-type foundations. Currently, the use of floating WTGs is being considered for wind farms located off the coast of Maine, California, Oregon, and Hawaii.
For European wind farms, only a small proportion of foundations have been sourced from outside of Europe. It has been considered a high-risk option for European developers, with reports of quality issues from Asian suppliers. Continued downward pressure on PPA and OREC prices may increase the trend towards supply from lower-cost countries now that the risk profile for other aspects of the projects is lower (e.g., supply chain disruptions, local content requirements, etc.).

Foundation production is relatively easy to set up and initiate operations, and large-scale manufacturing plants are not in operation in Europe; therefore, production of GBS foundations is likely to be one of the OSW supply chain components which will be localized early in the U.S.

- *Through 2023*: The annual wind farm production rate increases from 0 to approximately 1 GW. The market is not sufficient for a U.S. investment and all foundation production is undertaken outside the U.S.
- *2024-2027*: The annual wind farm production rate is approximately 3 GW. Monopiles will be the foundation of choice in water up to about 40 meters. GBS foundations have been selected for Equinor's Empire Wind project and these could be cost effective compared with jackets installed using feeders. Jackets and transition pieces (TPs) are likely to be localized in the U. S. but monopile production requires higher volumes for investment. The manufacturing and installation of secondary for installation of TPs and foundation pieces will be conducted in the U.S., as is envisioned at the port of ProvPort with Ørsted.
- *2028 - Beyond*: The annual wind farm production rate is greater than 2 GW. Any U.S. investments will have been made at this stage and the picture is unlikely to change significantly.

4.1.6. Subsea Cables.

Subsea cables are typically produced from specialty facilities with load-out facilities that can accommodate CIVs. The European market is dominated by four suppliers, all with European factories, with only LS Cable supplying cables from a facility located in Asia.

If investment in U.S. subsea cable manufacturing capacity were to follow the same pattern as Europe, we would expect to see investment at existing facilities, based upon the following:

- Nexans, with support from Ørsted and Eversource has invested at its existing South Carolina manufacturing facility[27], which has river access, to be prepared to make OSW export cables from 2021 on.
- Aker Solutions has modified an array cable manufacturing line in their Alabama facility to support offshore wind[28].

[26] Floating offshore wind, what is it and how does it work? - Iberdrola
[27] orsted-eversource-us-supply-chain-investment-enables-offshore-wind-cable-facility-expansion-in-sc (southforkwind.com)
[28] Source: Business Network for Offshore Wind "U.S. Offshore Wind Market Report and Insights 2020"

- Avangrid entered an agreement with Marmen Utility to supply some subsea cables for its Park City Wind project from its existing Seymour, Connecticut factory.

Cable manufacturers typically produce high voltage (HV) (>132 kV) cables separately from medium voltage (33 kV-66 kV) cables. High voltage cables require a vertical extrusion tower (about 130 meters in height), which is utilized to produce the insulating layers for the cable and the higher investment costs mean that suppliers dedicate these facilities for HV cable production.

- *Through 2023*: The Nexans South Carolina and Marmen Utility factories can supply HV cables for one project every two years. All other cables are imported from Europe and Asia.
- *2024-2027*: There is no change.
- *2028 - Beyond*: An additional U.S. investment in a HV cable factory is made and this is likely to be associated with an initiative to construct an offshore wind transmission spine.

4.1.7. Logistics and Installation

A large proportion of the capital expenditures in the construction of an offshore wind farm is in the Transportation and Installation (T&I) sector. Each component has its own T&I profile, and these profiles determine how the components must be handled and what special considerations the associated manufacturing and/or marshaling port must contend. As OSW components become larger and the turbines reach greater heights, the storage, transportation, and installation concepts become more complicated and the associated ports configuration become increasingly important. Efficiency is the key to sucessful wind farm installations, and the ports play a significant role in determining the level of efficiency the installation process experiences. As such, the ports typically have the following attributes: (1) sufficent acreage and surface bearing capacities to allow ease and safe of handling of components during the component-receiving operation and onsite staging; (2) sufficient facilities for the testing and final fabrication of components prior to shipment to the installation sites; and, (3)a quayside configuration that will allow for efficient load-out of components for transport to the wind farm and load-in of components manufactures elsewhere.

Figure 14 – Blades being transported by jackup barge

4.1.8. Turbine Installation

The European model for turbine installation is to load up to five turbine sets on a WTIV, with the tower fully erected and the blades loaded individually on a blade rack. Where possible, installation is from an integrated manufacturing/construction base port. If this is not possible, or the wind farm is too far from production facilities, then an additional manufacturing/construction base port is leased during construction. As available waterside real estate along the U.S. East Coast is restricted, the second scenario referenced above is likely to be the scenario utilized as the U.S. OSW industry develops.

Feeder vessels/barges (hereafter referred to as *feeders*) have not been used for turbine installation operations in Europe because of the additional mobilization costs for the feeders, the wide range of suitable ports near project sites without associated air-gap restrictions, and the significant, perceived challenges of transferring sensitive turbine components between vessels in open sea, as well as changing their orientation from horizontal on the feeder (required if there are air-gap restrictions) to a vertical orientation for installation.

The European installation vessel model is unlikely to be applicable to the U.S. market, at least initially, due to the following:

- There are no suitable Jones Act-compliant WTIVs currently available, with the Dominion vessel being constructed and committed to use out of New London;
- Few U.S. properties can accommodate a manufacturing and construction base port due to area and ground-bearing capacity requirements;
- Many ports along the East Coast have air draft restrictions caused by bridges and/or overhead power transmission lines, with the ports in New London and Bridgeport not having any such restrictions, a key strategic advantage for the State; and,
- Distances from marshalling/construction base ports to U.S. windfarm sites are substantial, adding cost to use expensive WTIVs for component transport.,

It should be noted that the feeder logistical model allows access to up-river ports and supply chain manufacturing facilities, adding economic benefit inland and not just in coastal areas.

> OSW 101: Section 27 of the U.S. Merchant Marine Act is known as the "*Jones Act*," and deals with domestic sea freight. It requires that all goods transported by water between U.S. ports (the windfarms are considered U.S. ports) to be carried on U.S.-flagged ships, constructed in the United States, owned by U.S. citizens, and crewed by U.S. citizens. It affects Offshore Wind installation as none of the existing international fleet of foundation and installation vessels are Jones Act compliant. These installation vessels cannot enter port to load components and transport them to the installation site, as they would in Europe. The fact that Revolution Wind has secured a commitment to be the first project to use the Jones Act Compliant Charybdis, from Dominion, is a significant advantage for the project and the State. Without such a vessel, components need to be transported to a wind farm site via alternative methods such as utilizing feeders.

A European-style WTIV logistical model compliant with the Jones Act is possible but unlikely in the short term because the costs and production durations of building the vessel are likely to be significantly higher than European vessels (mostly built in Asia). It would also only make sense if it could collect and transport components as in Europe and the constraints of many East Coast ports make this problematic due to air gap restrictions.

The increasing size and mass of turbines and foundations has led to a divergence of the existing European WTIV fleet. WTIVs need a higher hook height but do not need a crane with the lifting capacity needed for foundation installation. A single WTIV will be able to install about one 1 GW project a year. In the well-respected consulting firm BVG's market assessment to 2024, with an annual installed capacity of up to 4 GW, three to four WTIVs will be needed.

WTIVs are very expensive to operate and lease, (costing anywhere from $200,000 to $300,000 per day); therefore, any technical problems to the vessel or an over-run to the construction schedule could expose the owner of the associated project to significant additional costs. Longer distances to suitable marshalling/construction base ports and a stronger and more competitive supply chain in up-river locations may make a feeder approach a more practical and economic solution in the U.S. market, as it allows the costly WTIVs to solely focus on the installation process and leaves the lengthy transit times to substantially less costly feeders.

It should be noted that, as predicted, the U.S. maritime industry is responding to the positive development in the U.S. offshore wind marketplace. In support of their OSW projects, Dominion has contracted for the construction of the first U.S.-flagged (and therefore Jones Act-compliant) WTIV named the Charybdis which is being constructed in Brownsville, Texas, at global marine shipbuilder firm Keppel AmFELS's shipyard, using domestically sourced steel. At peak construction, 1,000 U.S. workers will be employed in the building of this vessel. It has also been reported that the Charybdis will first be deployed out of the New London State Pier to support the construction of Revolution Wind and Sunrise Wind, both under joint development by Ørsted and Eversource, to serve nearly one million homes in Rhode Island, Connecticut, and New York[29]. It has also been reported that multiple entities are in the process of designing and building Jones Act-compliant feeders specifically to support the build-out of the U.S. first-mover OSW projects[30].

Industrialization Conclusions: it seems likely that the U.S. market will adopt and optimize WTG installation strategies based on feeders, with the WTIV providing only a crane for the transfer of components and installation. This WTIV could be Jones Act compliant, designed for this purpose, or a global vessel as it would remain at sea and not need to transport any materials between U.S. ports.

In the anticipated U.S. logistical model, each feeder would carry a single turbine set and utilize a practical and reliable method to enable the transfer of components out at sea. Using jack-up feeders results in substantial additional cost resulting from the jackup legs/spuds and does not eliminate the issue of bridge clearance heights. Motion compensated platforms add complexity and cost; however, innovative component transfer technology is evolving in parallel with feeders. Installation of a single turbine takes less than 24 hours. A project would need to use two or more feeders to ensure that the WTIVs remains active.

Considering that at least two thirds of the anticipated U.S. windfarms are in regions with significant infrastructure limitations (i.e., available acreage, air-gap restrictions, water depths, etc.), a feeder solution is likely to prevail as it also opens additional ports and suppliers upriver from bridges.

In general, developers would prefer to leave the selection of the marshalling/construction base port to the turbine-installation contractor (or the foundation-installation contractor in the case of foundations). Developers may take out a lease on a port to secure a facility if the availability of suitable

[29] https://news.dominionenergy.com/2021-06-01-Dominion-Energy,-rsted-and-Eversource-Reach-Deal-on-Contract-to-Charter-Offshore-Wind-Turbine-Installation-Vessel.
[30] https://www.workboat.com/people-products/friede-goldman-product-eliminates-motion-between-vessels-in-offshore-wind-turbine-installation-projects-company-says.

sites is constrained or investment in a port needs to be triggered early. If the port is leased by the turbine supplier, then it is less likely that the same site will be used for foundation installation because the requirements are different. For example, for monopile installation campaign from a floating vessel, bridges are less likely to represent a significant a constraint.

4.1.9. Foundations - BoP Installation

For monopiles, the European practice is to carry three to four monopile/TP sets per installation vessel. Because the components are anticipated to come from different locations, they are likely to be shipped to a marshalling/construction base port ahead of installation. Out at the wind farms themselves, the monopiles are driven into position and the TPs are grouted or bolted on to complete the installation of the primary foundation elements. For jacket foundations, the usual practice is for the pin piles to be installed first using a piling template, then a separate operation is performed to install the jackets over the pin piles.

For monopiles and jackets, the installation vessels used are likely to be different from those utilized to install turbines because jack-ups are not essential. Monopiles and TPs are likely to be installed in the same way as in Europe. For jackets, a feeder solution strategy might involve shipping the jacket and the pin piles on the feeder barge, and then lower the jacket into place and drive the pin piles through the base of the jacket.

For both monopiles and jackets, projects will probably use a marshalling/construction base port separate from the manufacturing facilities. Developers may consider direct delivery from foreign manufacturers direct to wind farm, so they don’t have to touch U.S. soil and have Jones Act compliance issues. This is only likely to be considered when there is a severe shortage of available ports or for smaller-scale projects.

For GBS foundations, there is no established practice in Europe for their large-scale production and installation. However, except for shallow-water sites, the strategy typically involves floating out the structures from the manufacturing facility to wind farm location before submerging the foundation with concrete ballast. The foundations are towed into their deployment locations using tugs and this is likely to be the approach used by Equinor for their Empire Wind project should they select the use of this foundation type. It is therefore unlikely that a separate marshalling/construction base port will be used for marshalling gravity base foundations, although they may be stored in shallow and sheltered locations before being taken to the offshore wind farm for installation.

For floating WTGs, the foundations can be manufactured in ports located up stream of restricting bridges, then towed to a much smaller port facility located downstream of any air gap restrictions for installation of top-side components.

4.1.10. Cable Installation

In Europe, for export and inter-array cables, the cable bobbins are likely to be picked up by the CIV from the factory quay side, and a specific marshalling/construction base port will not be required. The cable-laying process is initiated as close as the CIV can get to the shore. The cable is then pulled to the shore and terminated at an interconnect point between the subsea and land cables. The CIV then moves offshore along the cable route to the offshore substation. The cable is typically simultaneously buried using a plow when seabed conditions permit. For rocky/bedrock conditions, the cable may be laid in a trench that was pre-cut by another specialty vessel, adding to cost and complexity of the installation process.

Export cable CIVs are fitted with large carousels to enable them to carry the full length of the cable on bobbins, which limits the requirements for an offshore joint connection(s), thereby simplifying installation and reducing potential failure or problem point at the connection. At the offshore substation, the cable is pulled through a J-tube and terminated. Although there is no requirement for marshalling/construction base ports, the cable-installation contractor will need port facilities for crew changes and supplies.

The installation of inter-array cables between the individual WTGs is more complex because of the requirement to pull in the cable at each turbine location. The pull-ins can take longer than the actual laying of the cable. The cable may be plowed or buried after laying, generally by a separate vessel. The cable may be loaded in pre-cut lengths with the ends prepared or cut to length offshore and fitted with connectors. The former can result in faster installation but can create problems if for some reason there is a problem at one of the WTG locations. Because the distance between the turbines generally varies, pre-cut lengths need to be installed in a specified sequence. Inter-array cable installation may potentially create demand for cable storage port; however, this such a port may not need to be that close to the wind farm site and any port with suitable warehousing and quay-side area could be used.

Cable installation practices are unlikely to differ significantly between Europe and the U.S., unless if there are distinctly differing seabed conditions. Seabed conditions are typically evaluated by a developer during the planning and assessment phases of a development project post-award of a BOEM lease area and state energy solicitation.

4.2. Offshore Wind Industry Port Configuration Needs for Various Uses

This section of the assessment is focused on the identification and preliminary quantification of the specific requirements for various port facility types (i.e., marshalling/construction base port, manufacturing, O&M, and storage ports) through the typical life cycle of an OSW project from manufacturing of selected components through long-term O&M operations.

4.2.1. OSW Farm Pilot Projects/Scenarios and Construction, Installation and Deployment

To effectively provide needed context into the ports-applicability discussion, the project team evaluated a series of scenarios related to the anticipated development strategies.

The rapidity of the development of the OSW industry has led to the increasing capacities of turbine technology over the last few years – and this trend continues. For instance, in 2014, a 6 MW turbine was considered state-of-the-art, and it was widely considered in the industry that maximum turbine ratings of 10 MW to 12 MW were reasonable to anticipate. Now, in 2021, 12 MW turbines have become standard, and the OSW industry is discussing the potential for turbine capacities of up to 14 to 16 MW as being available for near-future projects. There have even been discussions of late indicating that 20 MW-class turbines may become available.

Based upon the evolution observed in the OSW industry which is trending toward larger-scale OSW farms with higher-capacity WTGs, the following scenarios have been selected for this evaluation:

- OSW farms of 800 MW and 1,200 MW overall capacities; and,
- Individual WTG capacities of 8 MW and 15 MW.

The table below lists minimum required port areas for deploying OSW projects in these scenarios based upon review of various studies and presentations on the facility requirements.

Min. required port area in acres		
	800 MW	1,200 MW
10 MW	59	82
12 MW	66	93
15 MW	66	91
20 MW	66	91

Table 3 Summary of the minimum required port area per turbine size and project class in acres.

There will be additional port requirements if OSW components are loaded directly onto Jones Act-compliant WTIVs, such as the Charybdis that will be used at State Pier in New London, instead of through the use of feeders:

- Port entry allowance for vessels with a total length of up to 700 feet and beam of up to 150 feet;
- Minimum water depth for port entrance and at load-out quayside of 30 feet;
- Sufficient bottom conditions at front of the load-out quayside to allow jacking operations with spud;
- No daylight restrictions for port entrance and departure;
- There are no downstream air-gap restrictions; and,
- No (or minimum) restriction due to tide or current.

4.2.2. Requirements for Generic O&M Port Facilities

This section discusses O&M Port requirements. The O&M services strategy is in general dependent on several factors, such as:

- Size of the wind farm (capacity);
- Distance to the wind farm from the O&M Port;
- Metocean conditions;
- Electricity price (PPA or OREC);
- Cluster effects with neighboring wind farms;

- Health, safety, and Environment (HSE) considerations; and,
- Service contract, etc.

As part of this evaluation, several service concepts have been established to address realistically anticipatable individual project and client requirements. Existing concepts also mirror the ongoing development of O&M service vessels and technological advancement (e.g., enhanced-vessel maneuvering, motion-compensated gangways, etc.). Established concepts include the use of CTVs, helicopter-based technicians transfer to turbines, the use of SOVs, and/or a combination thereof.

Equipment Type	Logistic Data	
CTV (small)	Speed	20 knots
	Length	66 feet
	Number of Technicians	12 Passengers
	Suitable Range	<20 nm
CTV (large)	Speed	25 knots
	Length	85 feet
	Number of Technicians	24 Passengers+ crew
	Suitable Range	<30 nm
Helicopter	Speed	75 mph
	Number of Technicians	6 Passengers+ crew
	Suitable Range	>20 nm
SOV	Speed	12 knots
	Length	295 feet
	Number of Technicians	60 Passengers+ crew
	Suitable Range	>20 nm

Table 4 : Overview on equipment type for different OSW service concepts

In Denmark and Germany, there are also examples available of OSW accommodation platforms as service hubs (e.g., hotels) for technicians. In general, the preferred choice for the service concept is strongly dependent on the distance from the O&M Port and the associated OSW farm. The close vicinity between a service port and a local airport also strengthens the position to support a helicopter-based service and CTV operations. It should also be noted that the "*geometry*" may potentially result in new O&M service models such as utilizing a "*mother*" SOV servicing CTVs which stay at sea via the SOV.

4.2.3. Evaluation of O&M Port Requirements

The use of CTVs, or CTVs in combination with helicopter operations, requires that an O&M Port facility be equipped with workshops, warehouses and buildings that contain offices, sanitary facilities, changing /shower rooms, laundry rooms, and most likely a cafeteria. In Europe, it is a common practice to provide leisure/recreational areas for technicians who are on standby due to poor weather conditions which preclude operations.

In case of SOV O&M operations, these hotel-type vessels provide such facilities and, as such, are not required for CTV-type O&M Ports.

Based on the distance between the port facilities in Connecticut and the planned sites for OSW farms ranging from over 50 nautical miles to 100 nautical miles offshore, and the average wind farm size of 800 MW, a likely choice for O&M operations is the utilization of SOVs, depending upon the final O&M Port location(s) and the OSW operator's choice of O&M service concept(s).

For CTV-type operations, the vessels pick up their crews, transit out to the offshore wind farms, support the daily work-flow components, then transit back to their base ports and drop off their crew members. In this case, the vessel crew members and OSW technicians live at home and congregate at the O&M port facility for work. For SOV-type operations, the vessels would only be periodically returning to the port for bunkering, revictualing, re-equipping and crew change. Ports for SOV operations require relatively free access to the berth and sufficient quay-side length to provide access for multiple vessels to operate simultaneously if several vessels are calling on the port (e.g., during severe weather conditions to seek shelter). However, an SOV-based service concept demands less area for staff activities in the port facility itself, as most of the required crew facilities will be located on the vessels themselves.

Independent of the O&M service concept, there is the potential that the port facility might also provide site areas for an operations building, including control room for monitoring and operations of the wind farm and the logistics of O&M operations. The establishment of an operations building most likely represents a commitment for the entire 25+ year life cycle of the wind farm which results in long-term employment opportunities. It further strengthens the position of a port as an established O&M service port; therefore, the requirements for related infrastructure (e.g., storage areas, buildings, etc.) are considered in this assessment.

For the purposes of this assessment, a maximum 2,000 MW OSW capacity off Connecticut was assumed to be developed by several different developers. Therefore, an O&M service port could potentially serve one or several projects operated by different entities (e.g., Ørsted, Eversource, Vineyard Wind, Avangrid, Mayflower, Equinor, EnBW, etc.). Additionally, O&M service contracts may potentially be entered into with components providers, such as nacelle OEMs. Such service contracts typically have durations ranging from five to 15 years. Satellite O&M service ports associated with these component services will likely be required in the vicinity of an OSW farm operator's primary O&M service port, regardless of their preferred use of SOVs, CTVs and/or helicopters. For example, an owner-operated O&M port might require the establishment and use of multiple satellite O&M facilities for several different parties across the supply chain.

The requirements assessed hereinafter consider development scenarios of up to 2,000 MW in various sized wind-farm tranches. However, the requirements formulated within this task in relation to workshop, warehousing and office spaces are related to overall capacity only, and do not consider that multiple OSW farm operators will require separate facilities. This means that having one operator servicing an 800 MW-wind farm (with ideally the same WTG type) has different requirements than two operators servicing two separate 400 MW-capacity wind farms which would potentially require each tenant to have control over its own facilities (warehouse, workshop, office, etc.), even on the same O&M facility.

The following provides a summary of the infrastructure required based upon O&M concept types, as well as the capacities and number of OSW farms being operated out of a modelled O&M facility utilizing the full range of O&M service concepts.

a) A design-facility for an 800 MW-capacity wind farm based on a CTV and helicopter-supported O&M service concept requires a minimum quay wall length of 200 feet when utilizing two large CTVs.

The area requirement for on-site support buildings comprises of approximately 13,000 feet^2, consisting of the following:

- Warehouse: 8,500 feet^2
- Workshops: 500 feet^2
- Office Building: 2,500 feet^2
- Other Facilities: 700 feet^2 (leisure area)
- Cafeteria/Food: 750 feet^2

Optional:

- Control Room: 600 feet^2
- Accommodations: 3,800 feet^2

An SOV-based O&M service concept requires a quay side of approximately 400 feet in length. Due to the fact that a large part of the required facilities are located on the vessel itself, there is a reduced demand for facilities in the O&M Port itself. The demand for floor areas in required support buildings to support SOV operations would be in the order of 10,500 feet^2.

b) A design-facility for an O&M service facility for one to four OSW farms ranging in capacities from 400 MW to 800 MW would require berthing spaces for all vessels employed. A marina-type facility for CTVs is an often-preferred solution as it would provide sufficient berthing spaces and protection from nearby large-vessel traffic. A separate marina facility for CTVs maintains free quay wall area for T&I activities at the marshalling/construction base port during construction, as well as construction activities associated with future OSW farms.

- In this scenario, area demands for storage, repair, and office space ranges between 10,500 feet^2 for a single 800 MW project serviced with one SOV only, to 25,800 feet^2 for four projects of up to a total capacity of 800 MW.
- Quay wall / berthing requirements range from 200 feet to 1,600 feet in length (see table above).

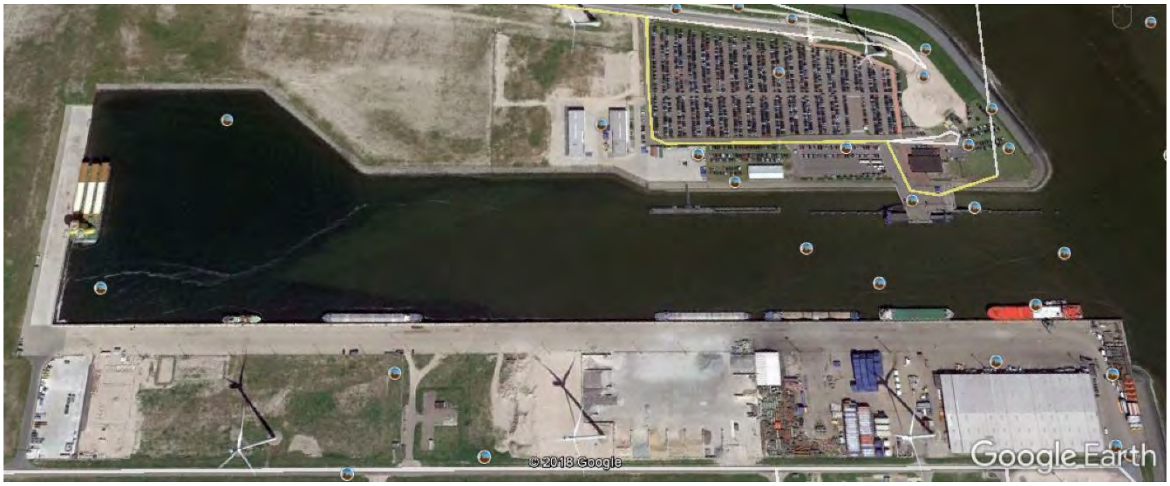


Figure 15 Port of Eemshaven with berthing for CTVs (top) and SOVs (bottom).

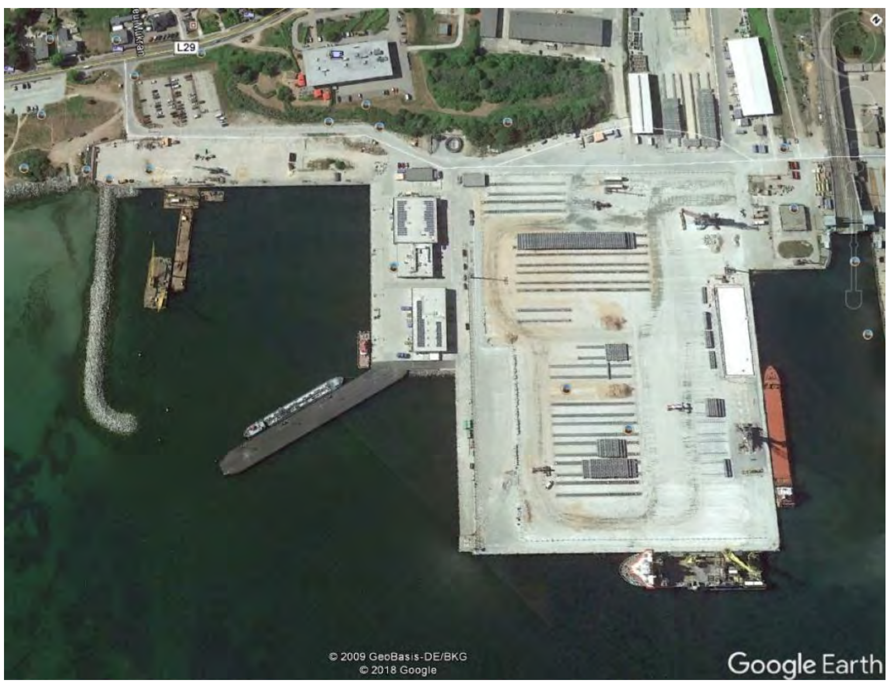


Figure 16 Port of Mukran with marina for service vessels

4.2.4. Secondary Steel/Minor Coating Port Requirements

This section provides an evaluation of infrastructure requirement for OSW manufacturing ports specializing in the fabrication and installation of secondary steel (e.g., platforms, ladders, railings, etc.), as well as minor application/repair of water-proof coating on damaged components, similar to what is anticipated to be performed at ProvPort by Ørsted. This assessment evaluates the port requirements associated with providing such services for the following components:

- 40-80 TPs; and,
- Two-to-four offshore substations (OSSs).

These two specific component types were selected as it is currently anticipated that other typical components (e.g., foundations, nacelles, towers, etc.) will be fully manufactured, assembled, coated, and certified as ready for installation prior to leaving their respective manufacturing facilities. However, other preparatory activities may require port facilities to cover two roles, including at a marshalling/construction base port and/or at a separate port facility wherein final assembly, repair and T&I preparation activities are conducted.

- Mounting of temporary outfitting required to support the transport of the component to site and offshore installation (e.g., facility and marine lighting, scaffoldings, sea fastenings, etc.);
- Rigging and load-out preparations;
- Rectification/repair of minor items identified during fabrication inspections and tests;
- Intermediate storage due to project delays; and,
- Repair of minor coating damages and/or mock-up tests.

4.2.5. Large-scale Component Manufacturing Port Facility

This section is prepared to provide an assessment of port facilities required to provide manufacturing services of various main OSW components including towers, nacelles, blades, monopiles and transition pieces. This assessment makes use of the lessons learned by the European OSW industry which has evolved over the last few decades and successfully supported the installation of grid-scale OSW farm facilities. Note that the purpose of this evaluation is not to provide potential layouts for specific port facilities; rather, its purpose is to provide an evaluation of the core-infrastructure requirements for an OSW Manufacturing Port including various work area requirements (spaces) and supporting required equipment (i.e., lifting equipment). Again, this evaluation has been developed utilizing the lessons which were hard learned in the fully developed European OSW marketplace.

4.2.6. Towers

This section provides an evaluation of the port infrastructure required to support the fabrication and storage of tower elements. European examples include facilities that are located in Ambau and Cuxhaven, Germany, as shown in the images below. In the current US Market, there is a commitment to Tower manufacturing out of the Port of Albany, in New York.

Figure 17 Port layout example for manufacturing and storage of towers.

Figure 18 Port Layout example for manufacturing and storage of towers.

Area Requirements (approx.)

Item	Length [feet]	Width [feet]	Total [feet^2]
Area Fabrication	755	328	247,640
Area Storage 1	656	574	376,544
Area Storage 2	755	492	371,460
Offices & Parking	164	328	53,792
Area Load-Out			914,932
Total Area Required			approximately 2,000,000

Table 5 Example of manufacturer areas used for tower fabrication

Other typical requirements (e.g., component-handling equipment) to support the fabrication and storage of tower elements include the following:

- SPMTs with payload capacities of up to 1,000 tons;
- Mobile cranes, forklifts, and cherry pickers with sufficient capacity for tower fabrication, assembling and preparation for offshore transport;
- Storage- and transport-frames;
- Mobile scaffoldings and housings;
- Rigging components (spreader beams, slings, shackles, etc.);
- Tower upending devices; and,
- Mobile power generators and masts lights.

4.2.7. Nacelles

This section provides an evaluation of the port infrastructure required to support the fabrication (assembly) and storage of nacelles. A European example includes the GE fabrication facility located in St. Nazaire, France. It's important to note that nacelles are not "manufactured" but are assembled of several manufactured sub-assemblies, which may be fabricated on site or off-site, or most likely, some combination of the two. Currently in the US market, there are commitments by OSW Developers to perform Nacelle Assembly at the New Jersey Wind Port facility.

Figure 19 Example fabrication layout for production/assembly of 100 WTG per year.

Area Requirements (approximate)

Item	Length [feet]	Width [feet]	Total [feet^2]
Area Fabrication	558	328	182,024
Area Storage (1)	558	279	155,682
Area Storage (2)	427	328	140,056
Offices	213	98	20,874
Parking	492	213	104,796
Total Area Required			Approximately 600,000

Table 6 Area requirements for Nacelle fabrication/assembly

Other typical requirements (e.g., component handling equipment) to support the fabrication and storage of nacelles include the following:

- SPMTs with payload capacity of up to 1,650 tons;
- Mobile cranes, forklifts, and cherry pickers with sufficient capacities;
- Storage- and transport-frames (according to WTG manufacturers specifications);
- Mobile scaffoldings and housings;
- Rigging components (spreader beams, slings, shackles, etc.); and,
- Mobile power generators and light masts

4.2.8. Blades

This section provides an evaluation of the port infrastructure required to support the fabrication and storage of rotor blades. A European example includes the LM Blade fabrication facility located in Castellon, Spain. Currently in the US market, there is a commitment by Siemens Gamesa to construct a blade manufacturing facility over 80 acres at the Portsmouth Marine Terminal[31].

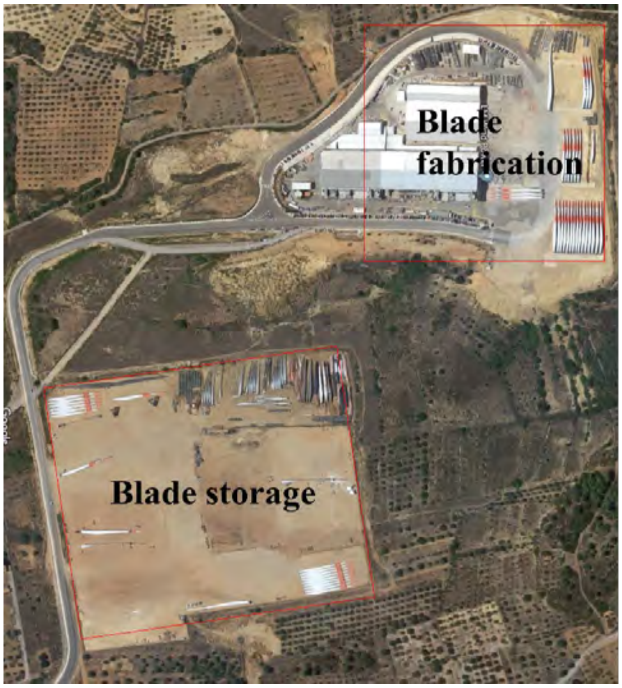


Figure 20 Layout of manufacturing and storage facility of LM Wind Blades.

Area Requirements (approx.)

Item	Length [ft]	Width [feet]	Total Area [feet^2]
Area Fabrication	853	853	727,609
Area Storage	919	1050	964,950
Offices & Parking	164	328	53,792
Total Area Required			approximately 1,300,000

Table 7 Area layout of blade fabrication at LM blades.

Other typical requirements (e.g., component handling equipment) to support the fabrication and storage of blades include the following:

- SPMTs with payload capacity of up to 500 tons;
- Mobile cranes, forklifts, reach stackers and cherry pickers with sufficient capacities;
- Storage- and transport-frames;

[31] Virginia Gets the First U.S.-Based Offshore Wind Blade Manufacturing Facility - The Virginia Star

- Mobile scaffoldings and housings;
- Rigging components (spreader beams, slings, shackles, etc.); and,
- Mobile power generators and light masts.

4.2.9. Monopile Foundations

This section provides an evaluation of the port infrastructure required to support the fabrication and storage of MP foundation elements. A European example includes the Steelwind Monopile fabrication facility located in Nordenham, Germany. Currently in the US market, there is a commitment by EEW to construct a manufacturing monopiles in Paulsboro, NJ.


Figure 21 Layout of MP fabrication and storage facilities at Steelwind.

Area Requirements	Length [feet]	Width [feet]	Total [feet^2]
Area Fabrication &	2,297	656	1,506,832
Area Storage	591	591	349,281
Area Load-Out	295	656	193,520
Offices & Parking	164	328	53,792
Total Area Required			approximately 2,100,000

Table 8 Area requirements for monopile foundation fabrication.

Other typical requirements (e.g., component handling equipment) to support the fabrication and storage of monopile foundation elements include the following:

- SPMTs with payload capacities of up to 3,000 tons;
- Crawler cranes or fixed cranes (single or tandem) with load capacities of up to 3,000 tons;
- Mobile cranes, forklifts, and cherry pickers with sufficient capacities;
- Storage- and transport-frames (according to manufacturer's specifications)

- Mobile scaffoldings and housings;
- Rigging components (spreader beams, slings, shackles, etc.); and,
- Mobile power generators and light masts.

4.2.10. Transition Pieces

This section provides an evaluation of the port infrastructure required to support the fabrication and storage of TP elements. A European example includes the Sif Massvlakte facility located in the Netherlands.

Figure 22 Layout for MP/TP storage at port of manufacturing

Area Requirements (approximate)

Item	Length [feet]	Width [feet]	Total [feet^2]
Area Fabrication	328	459	150,552
Area Storage 1	328	853	279,784
Area Storage 2	328	328	107,584
Area Load-Out	164	328	53,792
Offices & Parking	164	328	53,792
Total Area Required			approximately 650,000

Table 9 Area examples for fabrication of transition pieces

Other typical requirements (e.g., component handling equipment) to support the fabrication and storage of TP elements include the following:

- SPMTs with payload capacities of up to 1,100 tons;
- Mobile cranes, forklifts, and cherry pickers with sufficient capacities;
- Storage- and transport-frames;
- Mobile scaffoldings and housings;
- Rigging components (spreader beams, slings, shackles, etc.); and,
- Mobile power generators and light masts

4.2.11. Summary and Conclusions:

The above section of the assessment provides a discussion of the specific requirements for various port types (i.e., marshalling/construction base port, manufacturing, O&M, and storage ports) through the typical life cycle of the development of an OSW farm. For construction, installation and deployment, OSW facility capacities (including laydown, assembly, and load in/load out areas), and facility requirements, for 800 MW and 1,200 MW projects were evaluated. These project capacities were selected considering typical U.S. OSW project sizes for the states that are issuing solicitations for the purchase of OSW power. Additionally, quay side and other facility requirements for O&M operations were evaluated based on typical vessel dimensions, crew service concepts, and O&M scenarios. Area requirements for secondary steel and large-scale manufacturing of towers, nacelles, blades, monopiles, and transition pieces were assessed considering component scale and “lessons learned” from current European OSW component manufacturing practices, and commitments, where they exist, to US manufacturing facilities.

This section of the assessment serves to provide an evaluation of the core-infrastructure requirements for various OSW port facilities (including area requirements, infrastructure requirements, and supporting equipment) to assess the capabilities of existing port infrastructure along the U.S. East Coast.

Based on the data reviewed, the following considerations were utilized in the assessment of port requirements for OSW projects in the U.S.:

- Project capacity sizes of 800 MW and 1200 MW were utilized based on typical procurement practices of the U.S. east coast states; and
- Turbine sizes of 10 MW, 12 MW, 15 MW, and 20 MW were included in the assessment based on current and predicted market trends.

The results of this portion of the study provided the basic parameters that inform the overall assessment of the U.S. market. These findings are summarized below:

- For the various project capacities assessed (800 MW and 1,200 MW), required acreage sizes for marshalling/construction base port ranged from 32 to 91 acres based on the turbine equipment sizes (10 MW through 20 MW) assumed.

Market drivers effecting the U.S. industry (such as LCOE, technological advancements, and state-procurement awards), are leading the industry toward larger projects and larger turbine sizes. In Connecticut and New England, 800 MW to 1,200 MW projects are becoming the norm. In addition, 12 and 13 MW turbines were recently made available to developers and are anticipated to be in common use which will result in an increase of the upland area needed per turbine at a port facility.

4.3. General Requirements for Offshore Wind Operation and Maintenance Ports

As OSW projects off the coast of southern New England advance, ports in the State have an opportunity to support the OSW infrastructure and supply chain needs of the emerging industry. The figures below show nautical mile (nm) distances from New London and Bridgeport to the BOEM offshore wind energy/lease areas. Current lease areas in Southern New England and potential lease areas in the New York Bight are within a 50 to 100 nm distance from these locations. This proximity to current and potential BOEM OSW lease areas presents an opportunity for Connecticut ports to service the OSW industry, and one potential port use is to support long-term O&M operations.

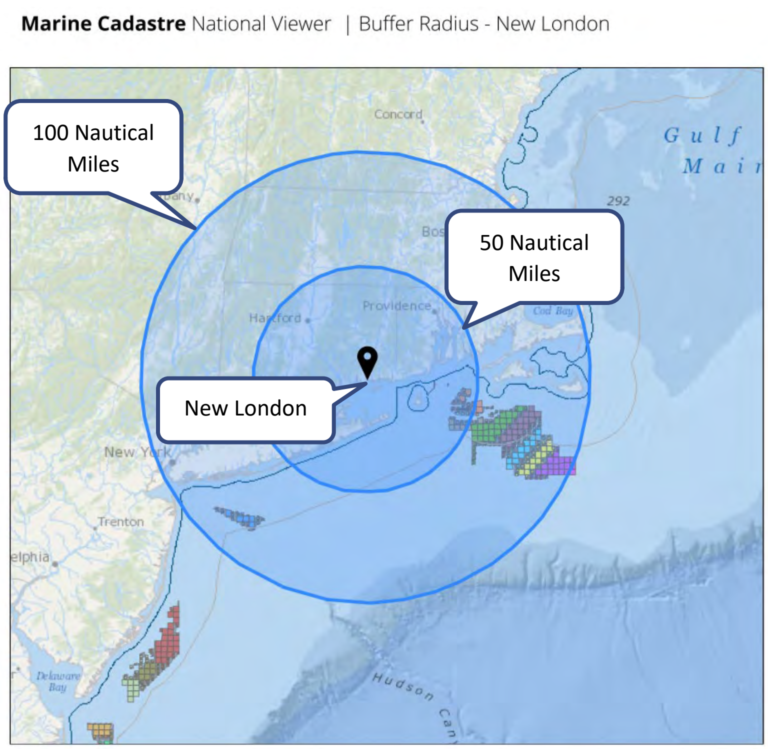


Figure 23 - 50 AND 100 Nautical mile distance rings centered on New London, CT
Current lease areas and Call Areas are shown

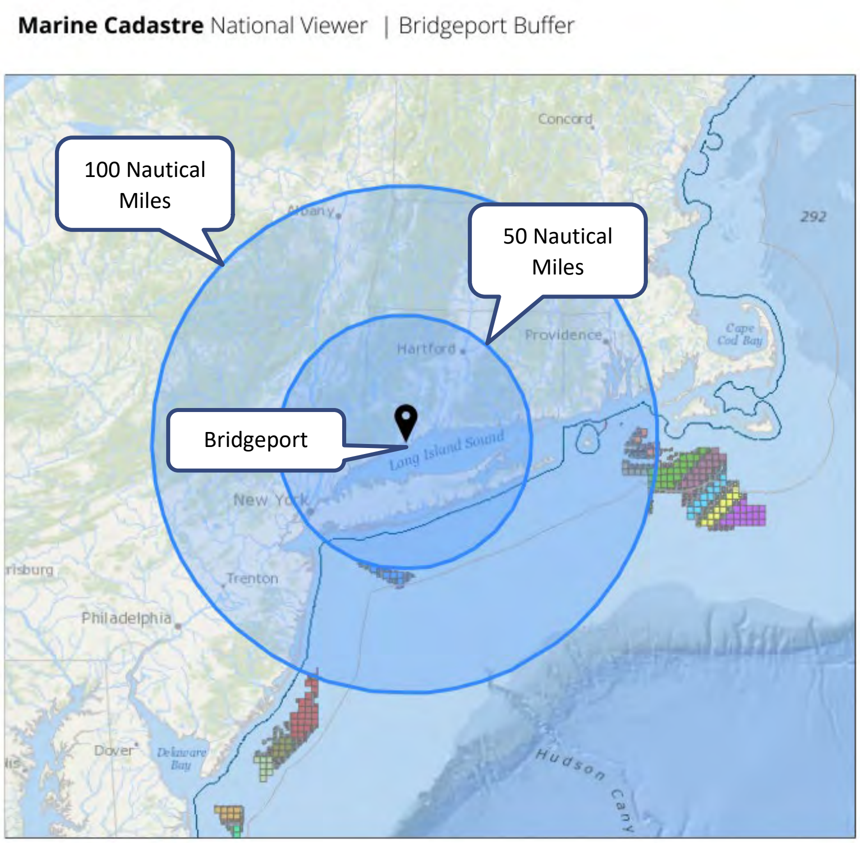


Figure 24 Nautical mile distance rings centered on Bridgeport, CT. Current lease areas and Call Areas are shown.

O&M port facilities are crucial to the functioning of OSW farms during their approximately 25 year projected operational life. Additionally, these ports serve as the center for the wide-variety of jobs associated with OSW O&M operations including vessels operations (e.g., CTVs and SOVs), wind-turbine technicians, logistics/operations, etc.). Typically, an O&M facility initiates operation as the construction of the wind farm nears completion. The main purpose of the O&M facility is to provide the infrastructure to house the technology (e.g., logistics/operations center), support personnel and technicians to remotely operate the wind farm, and the technicians, equipment, and vessels necessary to conduct regular inspections and to complete required repairs. Further, O&M facilities stock a level of replacement components onsite and, as such, typically require a warehouse and staging area.

While the facility should be located on the waterfront (or proximal to the waterfront) with access to docks and a quay side, it can be relatively small in size, and unlike other facilities needed for OSW (e.g., marshalling, equipment staging, etc.), it can be a multi-use facility, utilized concurrently for other non-O&M uses, including non-offshore-related purposes. An O&M facility typically needs to house the following components:

- An operations building with the computer equipment needed to operate and monitor the turbines and other systems of the wind farm, and the communications equipment required to connect maintenance and inspection crews with the O&M base and the service vessels;
- Facilities to host either two to three CTVs or one SOV which transport the inspection and maintenance crews to the wind farm during operation; and,

- A relatively small warehouse to house the inspection equipment and light supplies and repair components commonly needed for non-structural repairs.

For CTV operations, the O&M facility should be located as close as possible to the wind farm to minimize the transit time for crews, as CTVs return to their base port at the end of each operational day. SOVs typically spend multiple days (approximately 7-14) offshore, and crews sleep onboard.

The following list represent the current industry-standard physical requirements of a potential O&M facility, including both CTV and SOV operations:

Site Considerations	Technical Requirement
Acreage	> = 2 acres on waterfront[32]
Channel / Entrance Width	>= 40 feet
Distance to Wind Energy Areas	< 50 nm (CTV) or <150 nm (SOV)
Potential Quayside (Bulkhead) Length	>160 feet (CTV) or > 200 feet (SOV)
Draft	>10 feet (CTV) or >12feet (SOV)

Table 10 Physical Requirements for O&M Facilities

There are multiple sites within the State that meet these O&M facility requirements; however, many of these waterfront sites currently host other businesses and uses. Decisions regarding O&M ports are driven primarily by the developers/operators of the wind farms, and commitments made during the state-procurement proposal process. With the large number of sites that could conceivably host O&M operations, and the difficulties in gauging owner and community interest in redevelopment, this report highlights the economic opportunity for O&M facilities but does not further investigate individual sites or provide multiple reuse scenarios.

4.4. Comparative Analysis – Supply Chain Needs to CT Available or Accessible Ports

Based on the Component Needs Analysis outlined above, and the composite list of State ports assessed, a comparative analysis was conducted to determine which port facilities in the State are appropriate to consider for which OSW activity(s) (e.g., marshaling, manufacturing, O&M, etc.). The resulting summary table was generated to frame the use scenarios section below. The lists of likely small and major port facilities noted in the sections below were compiled through the ports assessment component of this study.

Small Port Facilities (< 10 acres in land area)

Connecticut, as a coastal state, has an abundance of waterfront properties and facilities. Additionally, its long maritime history, coupled with a coastal economy that includes numerous Navy and Coast Guard facilities and the related supply chain, means that the working waterfronts are active and engaged in supporting and conducting maritime-related operations.

[32] A two-acre cut off is used for potential sites. A waterfront two-acre site can be used for general vessel operations. It is anticipated that sites with less than five acres will require more space (for parking, warehouses, etc.) that does not need to be directly at the quayside but in proximity to the site.

Port Facilities – Small (<10 acres – suitable for O&M or Storage)

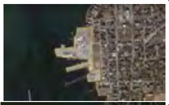
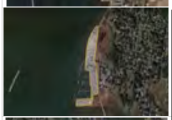
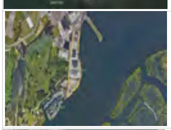
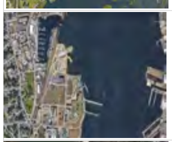
	Name	Town	Acres	QuaysideType	Channel Depth	Berth Depth	Channel Width	Distance to Deep Water (24ft)	Distance to MA WEA	Ownership
	(<10acres)									
	Town Dock	Stonington	5	Wharf/Dock	~13-ft	~17-ft	1200-ft	4000-ft (0.66nm)	66.8 mi	Dept of Public Works
	Saybrook Point	Old Saybrook	9	Dock	~22-ft	~6-ft	200-ft	6000-ft(0.99nm)	91.3mi	The Tagliatela Family
	Sound Yachting	Westbrook	8	Dock	~6-11-ft	~5-ft	156-ft	3157-ft(0.51nm)	96.2mi	Ted Novakowski
	Joyride Charters	Westbrook	6	Dock	~6-11-ft	~5-ft	156-ft	3157-ft(0.51nm)	96mi	Joy Sherman
	Crimbo Point	Stratford	8	Dock	~5-10-ft	~7-ft	441-ft	7500-ft	130mi	C. Richard Polzello
	Shaw Neck	New London	6.8	Wharf	~19-42-ft	~14-ft	1600-ft	1500-ft	77.6mi	TBD
	Cedar Island Marina	Clinton	8	Dock	~3.5-9ft	~3.5-ft	220-ft	~10000-ft	101mi	Jeffery Shapiro
	Guilford Town Marina	Guilford	4	Dock	~5.5-ft	~5.5-ft	100-ft	~9500-ft	110mi	Bernard Lombardi
	Seaside Park	Bridgeport	8	Dock	~30-ft	~5-ft	1180-ft	~800-ft	135mi	Town of Bridgeport

Table 11 Small Ports. Assessment for Offshore Wind O&M and Storage Port Use

Major Port Facilities (> 10 acres in land area)

Grade	Definition	Examples of Upgrades Needed
Green	Site is suitable for the activity with minimal upgrade needs	Re-grading, re-paving
Yellow	Site is suitable for the activity with some significant upgrades	Maintenance Dredging, filling to increase bearing capacity, strengthen existing waterside infrastructure
Orange	Site is suitable for the activity with some major upgrades	Extensive improvement dredging, new waterfront infrastructure, significant environmental remediation, or mitigation
Red	Site is not suitable for the activity	Air Draft limitation, lack of area, insufficient water depth

Table 12 Relative Ranking of Port Suitability for each Offshore Wind Activity.

Heat Chart - Comparison of Offshore Wind Component Port Requirements with CT Ports

Port	Construction / Marshalling	Storage	O & M	Manufacturing									
				Steel Foundations	Concrete Foundations	Transition Pieces	Tower Sections	Nacelle	Blades	Secondary Steel	Cable	Generator	Substation
New London State Pier*	Green	Green	Green	Red	Red	Yellow	Yellow	Orange	Orange	Green	Yellow	Orange	Orange
Mohawk Northeast Construction–New London	Red	Orange	Orange	Red	Red	Yellow	Green	Orange	Orange	Green	Orange	Orange	Orange
Pequot Crossing - Waterford	Red	Orange	Orange	Red	Red	Red	Yellow	Orange	Orange	Yellow	Orange	Orange	Orange
Dominion Mill Stone - Waterford	Orange	Orange	Orange	Orange	Orange	Orange	Orange	Orange	Orange	Orange	Orange	Orange	Orange
Branford Marina - Branford	Orange	Yellow	Green	Red	Red	Red	Red	Red	Red	Yellow	Red	Red	Red
New Haven Terminal	Red	Yellow	Green	Red	Red	Red	Red	Orange	Orange	Green	Orange	Orange	Orange
Stratford Army Engine Plant	Red	Orange	Orange	Red	Red	Red	Orange	Orange	Orange	Orange	Orange	Orange	Orange
Barnum Landing - Bridgeport	Orange	Yellow	Green	Red	Red	Orange	Red	Red	Red	Green	Red	Red	Red
Cooks Point – Bridgeport (Former Derecktor Shipyard)	Orange	Yellow	Yellow	Red	Red	Orange	Orange	Orange	Orange	Yellow	Orange	Orange	Orange
Barnum + Cooks Point Combined	Orange	Yellow	Yellow	Red	Red	Orange	Orange	Orange	Orange	Yellow	Orange	Orange	Orange
PG & E Facility - Bridgeport	Orange	Orange	Orange	Red	Red	Orange	Orange	Orange	Orange	Yellow	Orange	Orange	Orange
Former Norwich Hospital Site- Norwich	Red	Red	Orange	Red	Red	Orange	Yellow	Orange	Orange	Yellow	Orange	Orange	Orange

*Once currently implemented upgrades are completed

Table 13 Comparison of OSW Component Port Requirements with State Ports

4.5. Port Infrastructure Assessment - New London/Groton/Waterford Area

The following provides "summary/report cards" for selected larger port facilities in the State.

Please note, these assessments were made independently of any of the property owners and developers, and typically without contact or consultation from them. These properties may or may not be available for OSW development and their inclusion in this report does not imply that they are available for development redevelopment. Our inclusion of specific properties within this report is only meant to illustrate their potential functionality for the OSW industry. Owners of other potential properties can utilize these selection metrics in the event that they desire to offer them to the marketplace at some point in the future.

4.5.1. State Pier

SITE SUMMARY CARD: New London State Pier			
	ATTRIBUTE	**INFORMATION**	**NOTES**
LOCATION	Municipality:	New London	
	County:	New London County	County starts on the CT-RI border then continues to the Connecticut River
	Port Governance/Security:	New London Police	Also: New London Harbor Master
	Distance to Shipping Channel:	300 ft (60.96m)	
	Distance to Open Ocean:	5 nm	
	Distance to Wind Lease Areas:	60 nm	
	Overhead Restrictions:	None	
	Channel Dimensions (width):	1,100 ft (335.28 m)	
	Channel Depth:	36 ft (10.97 m)	
	Distance to Major Roadway:	2,000 ft	I95
	Distance to Rail connection:	500 ft	Will be brought to the Site
	Navigational Restrictions/ Considerations:	None	
USE CLASSIFICATION	Ownership (Private v. Public):	public	
	Zoning Classification:	Industrial	
	Neighborhood Type:	Residential	Residential/Commercial Surrounding.
	Proximity to Non-Industrial Use:	2,300ft	
	Environmental Restrictions:	NA	Unknown

CHARACTERISTICS	Total Acreage:	45 ac	
	Open Acreage:	~43.71 ac	
	Acreage covered by Structures:	~1.29 ac	
	# Buildings Onsite:	2	
	SF of Building Space:	104,900 ft	
	Acreage of Paved Area:	~42	
	Acreage Available for OSW Uses:	~40	
	Upland Bearing Capacity:	2000 psf	To be Improved to 5,000 psf at the heavy lift pad and 3,000 psf the rest of the site

SITE SUMMARY CARD: NEW LONDON STATE PIER			
	ATTRIBUTE	INFORMATION	NOTES
WATERSIDE INFRASTRUCTURE	Quayside –Type:	Wharf/Pier	
	Quayside Length:	4000ft (1219.2m)	
	Wharf Construction:	None	
	Quayside – Condition:	poor	
	Quayside Bearing Capacity:	TBD	
	Cranes:	None	
	Berth – Depth:	36ft	
	Berth – Length:	1000ft	
	Berth – Width:	270ft	
	Berth – Substrate:	Sand & Silt	
	Fendering – Type:	rubber	
	Fendering – Condition:	Fair	
	Utilities Available at Berth:	None	

Table 14 New London State Pier Site Summary Card

Notes:

1. Load bearing capacity estimated through design reports without direct testing.
2. Information compiled from public records.

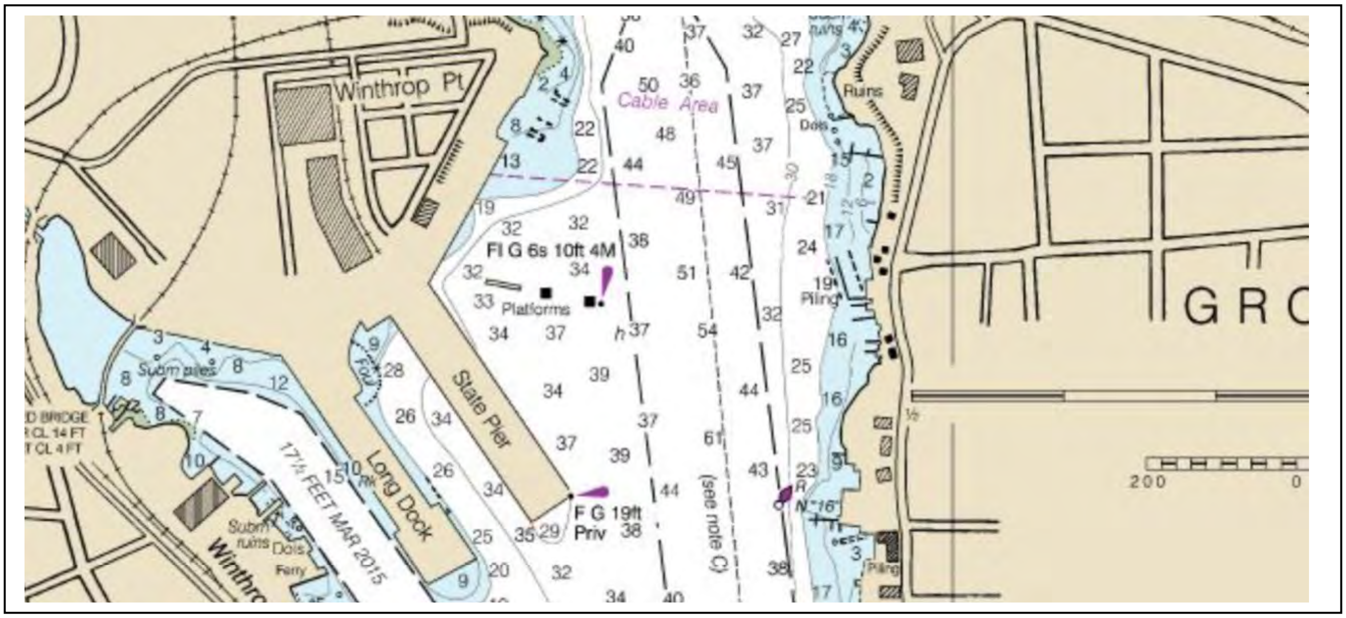


Figure 25 State Pier NOAA Navigational Chart

Potential CT Offshore Wind Marshalling / Manufacturing Port

State Pier	New London, CT	52 acres (after improvements)	210,565 m²

Port Facility	Harbor Setting	48 Useable Acres	194,249 m²
Quay Upgrades Needed = Y (in process)	3 Quays (2 x 1,000-ft / 305-m) (1 x 715-ft / 225m)		Dist. Open Ocean = 3 nm
Berth/Channel Depth = 36 ft / 11 m (after improvements)	Channel Width = 500 ft / 152 m		Distance to WEA = 73 nm
Upland Ground Condition = 4,800 psf / 23 tsm	Upland Surface = Paved		Bridge Air-draft Restrictions = None
Port Authority Owner	Upgrades currently under way	Groton Airport = 2.5 mi	Contamination = Low
Upgrade Costs for OSW = Moderate			

Figure 26 State Pier Key Highlights

4.5.2. Fisherman's Landing

As discussed above, the current owner of this property, and several following properties, were not contacted as part of this analysis.

Figure 27 - Fisherman's Landing - New London

SITE SUMMARY CARD: Fisherman's Landing

	ATTRIBUTE	INFORMATION	NOTES
LOCATION	Municipality:	New London	
	County:	New London County	
	Port Governance/Security:	New London Police	Also: New London Harbor Master
	Distance to Shipping Channel:	900ft (274.32 m)	
	Distance to Open Ocean:	5.21 nm (9.66 km)	
	Distance to Wind Lease Areas:	60 nm	
	Overhead Restrictions:	None	
	Channel Dimensions (width):	2,360 ft (719.3 m)	
	Channel Depth:	19 ft and 36-42 ft	
	Distance to Major Roadway:	>1 mile	I95
	Distance to Rail connection:	>1 mile	
	Navigational Restrictions/ Considerations:	None	
USE CLASSIFICATION	Ownership (Private v. Public):	public	
	Zoning Classification:	Residential	
	Neighborhood Type:	Residential	Residential/Commercial Surrounding.
	Proximity to Non-Industrial Use:	1000 ft	
	Environmental Restrictions:	None	
CHARACTERISTICS	Total Acreage:	8.4 ac	
	Open Acreage:	~8 ac	
	Acreage covered by Structures:	~0.4 ac	
	# Buildings Onsite:	1	

	SF of Building Space:	2,200 ft^2	
	Acreage of Paved Area:	0 acres	
	Acreage Available for OSW Uses:	~8	
	Upland Bearing Capacity:	1,000 psf	

SITE SUMMARY CARD: Fisherman's Landing

	ATTRIBUTE	INFORMATION	NOTES
WATERSIDE INFRASTRUCTURE	Quayside –Type:	Dock Wharf	
	Quayside Length:	200 ft 200 ft 100 ft 150 ft	
	Wharf Construction:	None	
	Quayside – Condition:	fair	
	Quayside Bearing Capacity:	TBD	
	Cranes:	None	
	Berth – Depth:	14 ft <8 ft	
	Berth – Length:	~200 ft	
	Berth – Width:	~100	
	Berth – Substrate:	Sand & Silt	
	Fendering – Type:	NA	
	Fendering – Condition:	NA	
	Utilities Available at Berth:	None	

Table 15 Site Summary Card - Fisherman's Landing

Notes:

1. Load bearing capacity estimated through engineer assumption without direct testing. Capacity information not available.
2. Information compiled from public records.

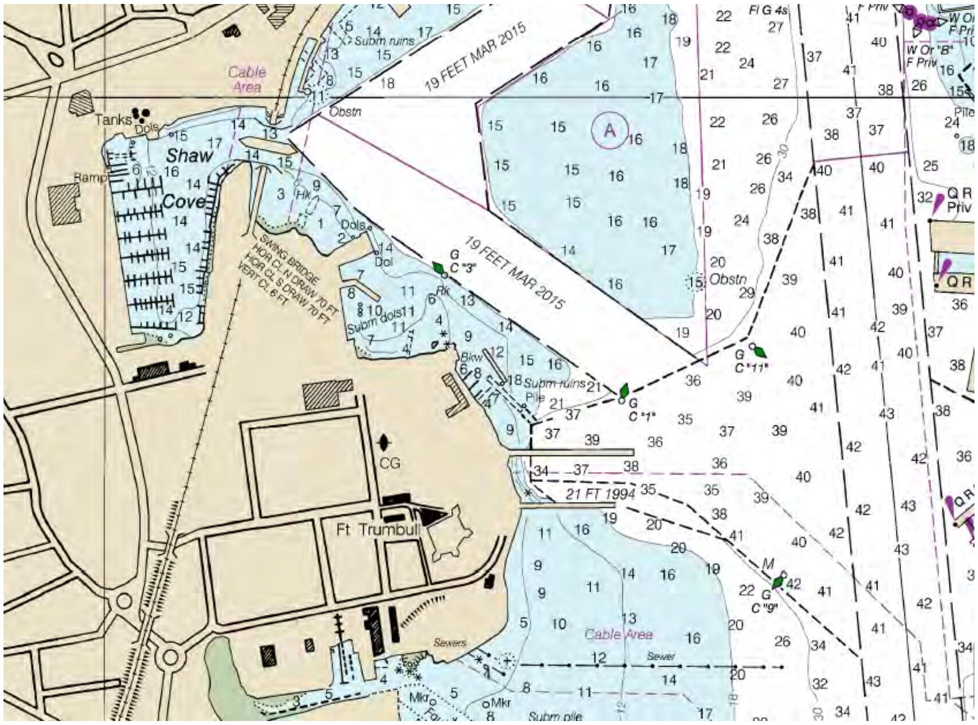


Figure 28 - Fisherman's Landing NOAA Navigational Chart

4.5.3. Mohawk Northeast

Figure 29 – Mohawk NE Facility – New London. Mohawk NE also holds riparian rights 400 feet out into the Thames River from their shoreline.

Figure 30 – Mohawk NE Facility – New London. Image showing Site Proximity to other significant sites

Figure 31 – Rendering of Proposed Upgrades to the Mohawk Northeast New London Facility.

SITE SUMMARY CARD: Mohawk NE Property			
	ATTRIBUTE	**INFORMATION**	**NOTES**
LOCATION	Municipality:	New London	
	County:	New London County	
	Port Governance/Security:	New London Police	Also: New London Harbor Master
	Distance to Shipping Channel:	800 ft (243.84m)	
	Distance to Open Ocean:	5.21 nm (9.65km)	
	Distance to Lease Areas:	70 nm	
	Overhead Restrictions:	-I-95 Bridge -Railroad Lift Bridge	-135 ft (vertical) and 500 ft (horizontal) -135 ft (vertical in up position) and 150 ft (horizontal)
	Channel Dimensions (width):	2,500 ft	
	Channel Depth:	approximately40 ft	
	Distance to Major Roadway:	500 ft	I-95
	Distance to Rail connection:	<100 ft	Extension available to site
	Navigational Restrictions/ Considerations:	None	
USE CLASSIFICATION	Ownership (Private v. Public):	Private	
	Zoning Classification:	Industrial	
	Neighborhood Type:	Commercial/Industrial	Residential/Commercial Surrounding.
	Proximity to Non-Industrial Use:		
	Environmental Restrictions:	Unknown	
CHARACTERISTICS	Total Acreage:	12acres	
	Open Acreage:	approximately7ac	
	Acreage covered by Structures:	approximately6ac	
	# Buildings Onsite:	5	
	SF of Building Space:	TBD	
	Acreage of Paved Area:	Approximately 4 ac	
	Acreage Available for OSW Uses:	Approximately 10 ac	
	Upland Bearing Capacity:	1,000 psi	

SITE SUMMARY CARD: Mohawk NE Property			
	ATTRIBUTE	**INFORMATION**	**NOTES**
WATERSIDE INFRASTRUCTURE	Quayside –Type:	None	
	Quayside Length:	NA	
	Wharf Construction:	NA	
	Quayside – Condition:	Na	
	Quayside Bearing Capacity:	NA	
	Cranes:	None	
	Berth – Depth:	2-10 ft	
	Berth – Length:	50 ft	
	Berth – Width:	60 ft	
	Berth – Substrate:	Unknown	
	Fendering – Type:	NA	
	Fendering – Condition:	NA	
	Utilities Available at Berth:	None	

Table 16 - Site Summary Card – Mohawk NE

Notes:

1. Load bearing capacity estimated through engineer assumption without direct testing. Capacity information not available.
2. Information provided by Property Owner or Operator or through public records.

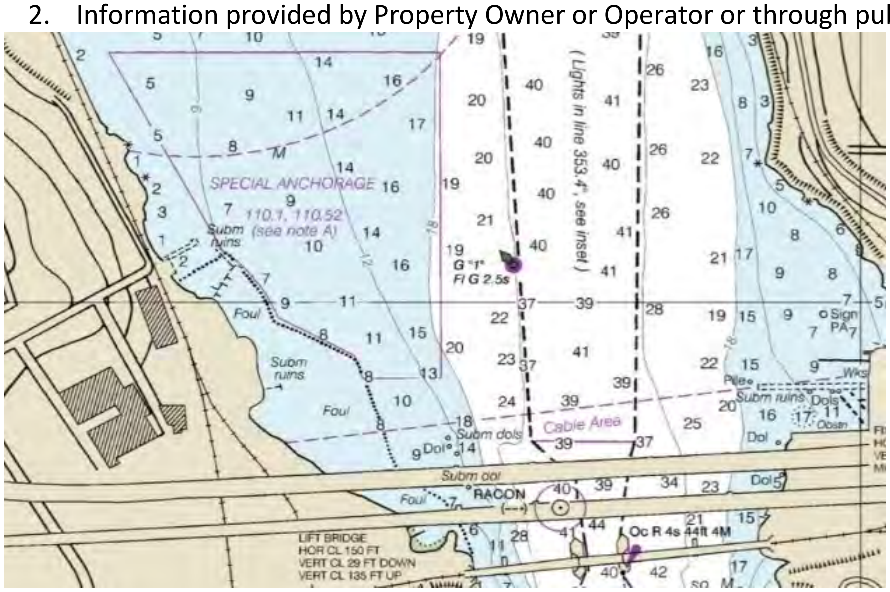


Figure 32 – NOAA Chart – Bathymetry Map

4.5.4. Pequot Crossings

As discussed above, the current owner of this property was not contacted as part of this analysis.

Figure 33 – Pequot Crossings- Waterford

SITE SUMMARY CARD: Pequot Crossings

	ATTRIBUTE	INFORMATION	NOTES
LOCATION	Municipality:	Uncasville	
	County:	New London County	
	Port Governance/Security:	Waterford Police	
	Distance to Shipping Channel:	500 ft (152.4m)	
	Distance to Open Ocean:	~8 nm	
	Distance to Wind Lease Areas:	70 nm	
	Overhead Restrictions:	-I-95 Bridge -Railroad Lift Bridge	-135 ft (vertical) and 500 ft (horizontal) -135 ft (vertical when in up position) and 150 ft (horizontal)
	Channel Dimensions (width):	1,600 ft	

	Channel Depth:	Approximately 40 ft	
	Distance to Major Roadway:	Fronting	I-395
	Distance to Rail connection:	Yes	
	Navigational Restrictions/ Considerations:	None	
USE CLASSIFICATION	Ownership (Private v. Public):	Private	
	Zoning Classification:	Industrial undeveloped	
	Neighborhood Type:	Indigenous Person Reserve	Residential/Commercial Surrounding.
	Proximity to Non-Industrial:	NA	
	Environmental Restrictions:	No environmental impairment Permitting- conversion of natural waterfront Native Heritage site	
CHARACTERISTICS	Total Acreage:	507 acres	
	Open Acreage:	Approximately 500 ac	
	Acreage covered by Structures:	0 ac	forest
	# Buildings Onsite:	0	
	SF of Building Space:	NA	
	Acreage of Paved Area:	None	
	Acreage Available for OSW Uses:	Approximately 500ac	
	Upland Bearing Capacity:	1,000 psf	

SITE SUMMARY CARD: Pequot Crossings			
	ATTRIBUTE	**INFORMATION**	**NOTES**
WATERSIDE INFRASTRUCTURE	Quayside –Type:	None	
	Quayside Length:	NA	
	Wharf Construction:	NA	
	Quayside – Condition:	Na	
	Quayside Bearing Capacity:	NA	
	Cranes:	None	
	Berth – Depth:	1-3 ft	
	Berth – Length:	NA	
	Berth – Width:	Sand/sediment	
	Berth – Substrate:	NA	
	Fendering – Type:	NA	
	Fendering – Condition:	NA	
	Utilities Available at Berth:	NA	

Table 17 – Site Summary Card – Pequot Crossings

Notes:

1. Load bearing capacity estimated through engineer assumption without direct testing. Capacity information not available.
2. Information compiled from public records.

4.5.5. Dominion Millstone- Waterford

As discussed above, the current owner of this property was not contacted as part of this analysis.

Figure 34 Dominion Millstone – Waterford

SITE SUMMARY CARD: Dominion Millstone			
	ATTRIBUTE	**INFORMATION**	**NOTES**
LOCATION	Municipality:	Waterford	
	County:	New London County	
	Port Governance/Security:	Waterford Police	Also: Waterford Harbor Master
	Distance to Shipping Channel:	2,500 ft (762 m)	
	Distance to Open Ocean:	~2 nm	
	Distance to Wind Lease Areas:	~50 nm	
	Overhead Restrictions:	None	
	Channel Dimensions (width):	No channel	on open water
	Channel Depth:	Water depth - 13-22 ft	
	Distance to Major Roadway:	5 mi	i95
	Distance to Rail connection:	<100 ft	
	Navigational Restrictions/ Considerations:	None	
USE CLASSIFICATION	Ownership (Private v. Public):	private	
	Zoning Classification:	Industrial	
	Neighborhood Type:	Power Plant	
	Proximity to Non-Industrial Use:	2,000 ft	
	Environmental Restrictions:	Unknown	
CHARACTERISTICS	Total Acreage:	82 ac	
	Open Acreage:	approximately 40 ac	
	Acreage covered by Structures:	approximately 40 ac	

	# Buildings Onsite:	<5	
	SF of Building Space:	TBD	
	Acreage of Paved Area:	approximately 60 ac	
	Acreage Available for OSW Uses:	Currently 0	Would need to be redeveloped
	Upland Bearing Capacity:	1,000 psf	
SITE SUMMARY CARD: Dominion Millstone			
	ATTRIBUTE	**INFORMATION**	**NOTES**
WATERSIDE INFRASTRUCTURE	Quayside –Type:	None	
	Quayside Length:	NA	
	Wharf Construction:	None	
	Quayside – Condition:	NA	
	Quayside Bearing Capacity:	NA	
	Cranes:	None	
	Berth – Depth:	3-9 ft	
	Berth – Length:	150 ft	
	Berth – Width:	Approximately 30 ft	
	Berth – Substrate:	Sand/silt	
	Fendering – Type:	NA	
	Fendering – Condition:	NA	
	Utilities Available at Berth:	None	

Table 18 – Site Summary Card – Dominion Millstone

Notes:

1. Load bearing capacity estimated through engineer assumption without direct testing. Capacity information not available.
2. Information compiled from public records.

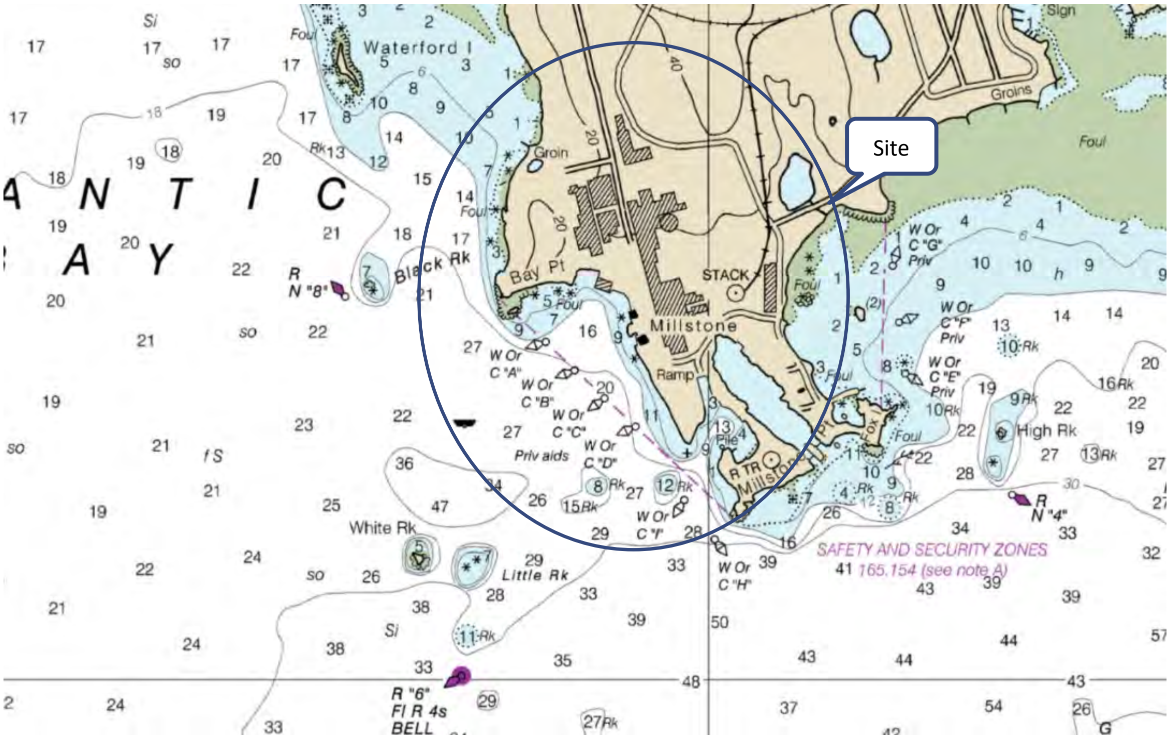


Figure 35 – NOAA Chart – Bathymetry Map of the Dominion Millstone Property

4.5.6. Norwich State Hospital

As discussed above, the current owner of this property was not contacted as part of this analysis.

Figure 36 – Aerial Photo – Former Norwich State Hospital – Preston, CT

Norwich State Hospital, Preston, CT – Encompasses approximately 393 acres adjacent to the Thames River approximately 10 nautical miles north of the mouth of the River at New London. The site is the former location of a State Hospital and has in the past been the site of medical as well as some industrial uses (evidence of two former oil holders along the river front on the south side of the property). Most of the property is vacant land with a few buildings (including the former hospital building and out-buildings). Approximately five acres of the property is the Brewster Neck Cemetery and is presumed to unavailable for redevelopment. A main rail line runs along the river front between the main property area and the river. A former long narrow (550-foot long by 10-foot wide) pier that was used as the offloading pier for petroleum product stored in the fuel holders at the site, juts out into the middle of the Thames River. The Site is currently under remediation. The Town of Preston and the which Mohegan Gaming & Entertainment (MGE) and the Town have an ownership transfer agreement for redevelopment (non-OSW related).

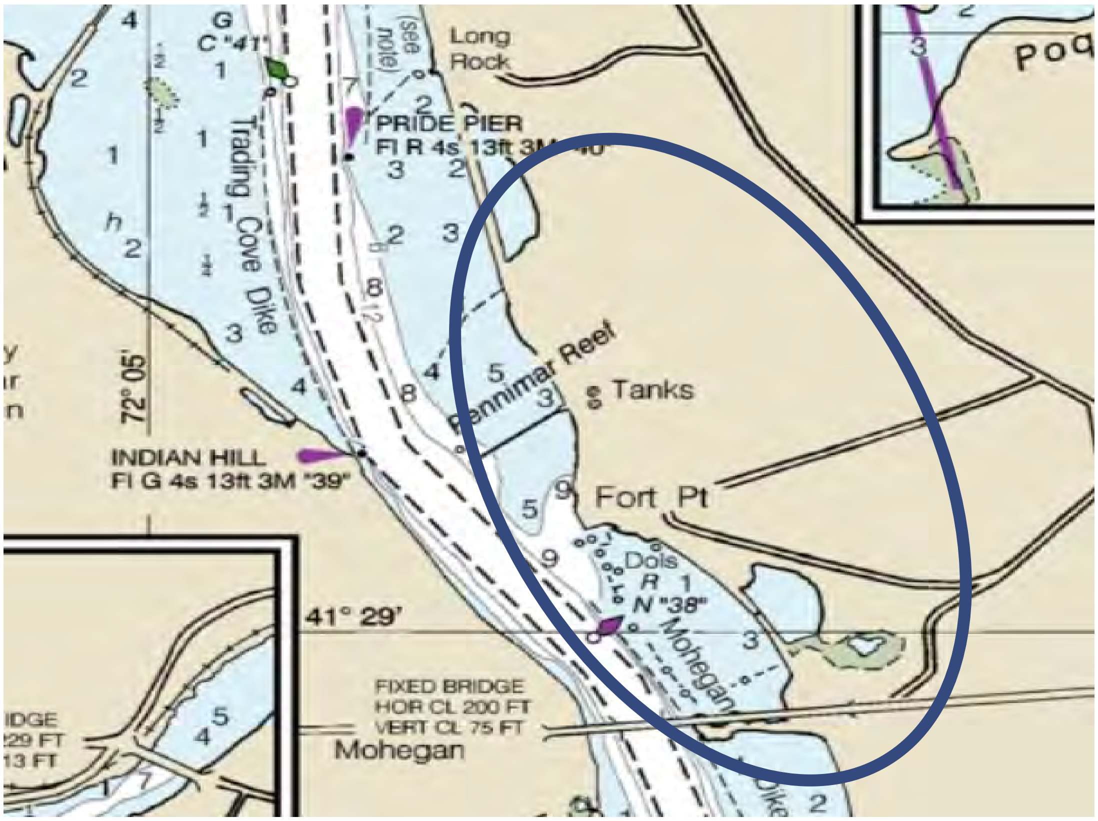


Figure 37 – NOOA Navigation Chart – Former Norwich State Hospital – Preston, CT

SITE SUMMARY CARD: Norwich State Hospital

	ATTRIBUTE	INFORMATION	NOTES
LOCATION	Municipality:	Preston, CT	
	County:	New London	
	Port Governance/Security:	NA	
	Distance to Shipping Channel:	550-feet	
	Distance to Open Ocean:	10 nm	
	Distance to Wind Lease Areas:	Approx. 130 nm	
	Overhead Restrictions:	3 Bridges	*Rt 2A Bridge:* 200’ horiz. /75’ vert. clearance. *I-95 Bridge, New London:* 200’ horiz. /135’ vert. clearance *AMRTRAK Rail Bridge:* 150’ horiz. /135’ vert. clearance.
	Channel Dimensions (width):	Appr. 25-feet	
	Channel Depth:	25-feet (MLW)	Channel needs maintenance dredging for full 25-foot depth.
	Distance to Major Roadway:	10 miles to I-95	
	Distance to Rail connection:	Rail is adjacent	Spur would need to be added.
	Navigational Restrictions/ Considerations:	Meandering River Path to Ocean.	Property is on Thames River 10 nm north of opening to ocean.
USE CLASSIFICATION	Ownership (Private v. Public):	Public	
	Zoning Classification:	Medical/Industrial	
	Neighborhood Type:	Mostly Undeveloped	
	Proximity to Non-Industrial Use:		
	Environmental Restrictions:	Onsite Water Bodies	Currently under remediation
CHARACTERISTICS	Total Acreage:	393-acres	
	Open Acreage:	350 +/-	Water bodies, rail line, cemetery
	Acreage covered by Structures:	< 10	
	# Buildings Onsite:	6	
	SF of Building Space:	>100,000 sq ft	
	Acreage of Paved Area:	Approx. 5 ac	Several small lots + maintenance lot

	Acreage Available for OSW Uses:	350 +	
	Upland Bearing Capacity:	<500 psf est.	Un-compacted land except where buildings and parking lots exist.

SITE SUMMARY CARD: Norwich State Hospital

	ATTRIBUTE	INFORMATION	NOTES
WATERSIDE INFRASTRUCTURE	Quayside –Type:	Fuel Pier	Pier has not been used in years. Expect poor condition
	Quayside Length:	30-feet	No real Quay. 30' wide headland for fuel dock on river
	Wharf Construction:	Timber	
	Quayside – Condition:	Poor	
	Quayside Bearing Capacity:	<500 psf	
	Cranes:	None	
	Berth – Depth:	3' – 20'	20' at dolphins at end of wooden pier. 3-5' deep at shoreline next to small Quay for pier.
	Berth – Length:	N/A	No real berth at site. Berth at end of fuel dock 600'+.
	Berth – Width:	N/A	
	Berth – Substrate:	River Sediments	
	Fendering – Type:	Dolphins	At end of fuel dock.
	Fendering – Condition:	Poor	
	Utilities Available at Berth:	Electric	Power to fuel pumps. Old and out of service.

Table 19 Site Summary Card – Norwich State Hospital

Notes:

1. Load bearing capacity estimated through engineer assumption without direct testing. Capacity information not available.
2. Information compiled from public records.

4.6. Port Infrastructure Assessment – Bridgeport Area

The Port of Bridgeport is likely to be the construction base of operations for Park City's Wind project. This deep-water port lies at the mouth of the Pequonnock River in southeastern Bridgeport. The main ship channel extends from Long Island Sound to the inner harbor. The federally maintained navigational channel has an authorized depth of -35 feet MLLW. From Long Island Sound to Tongue Point, the channel is 35 feet deep and 400 feet wide. It widens to 600 feet at the northwest bend (opposite Cilco Terminal), then narrows to 300 feet at a point 800 feet before the Stratford Avenue bridge as it heads up the Pequonnock River. The deepening of this channel to 35 feet was completed in 1963. However, over time, areas of the channel have filled in and shoals have developed throughout the channel. As shown on the USACE's channel shoaling report[33] below, there are several areas of somewhat significant shoaling.

LOCAL CCI\Shoaling Report Page 1 of 1

Bridgeport Harbor Connecticut						Date 08/19/2020
Sheet Name	Depth	Left Outside Quarter	Left Inside Quarter	Right Inside Quarter	Right Outside Quarter	Survey Name
Bridgeport Harbor 35-Foot Entrance Channel	35	29.2	26.6	30.8	26.3	CT_26_BRH_20200709_CS_033
Bridgeport Harbor 35-Foot Lighthouse Reach	35	24.2	29.8	34.2	32.1	CT_26_BRH_20200709_CS_033
Bridgeport Harbor 35-Foot Inner Harbor Reach	35	21.4	26.2	24.3	21.1	CT_26_BRH_20200709_CS_033
Bridgeport Harbor 18-Foot Southwest Anchorage	18	14.9				CT_26_BRH_20200709_CS_033
Bridgeport Harbor 25-Foot Southeast Anchorage	25	25.5				CT_26_BRH_20200709_CS_033
Bridgeport Harbor 35-Foot Turning Basin	35	22.1				CT_26_BRH_20200709_CS_033
Bridgeport Harbor 18-Foot Northwest Anchorage	18	13.6				CT_26_BRH_20200709_CS_033
Bridgeport Harbor 25-Foot Southeast Anchorage	25	21.3				CT_26_BRH_20200709_CS_033

7 or more feet above project depth
5 or 6 feet above project depth
3 or 4 feet above project depth
1 or 2 feet above project depth
At or 1 foot below project depth
2 or 3 feet below project depth
4 feet or more below project depth

Table 20 – USACE Bridgeport Channel Shoaling Report

The USACE is responsible for dredging to maintain depths of the Federal channel and addressing this shoaling. Due to the industrial history of Bridgeport Harbor, some of the sediments within the harbor will be unsuitable for offshore disposal. Therefore, the USACE is currently drafting a Dredge Material Management Plan (DMMP) to identify strategies and options for the dredging and disposal of the different sediments likely to be encountered as part of its maintenance dredge activities. According to the 2010 draft DMMP and in accordance with our discussions with the USACE Project Manager, there are over 1,100,000 cubic yards of sediments unsuitable for offshore disposal within the harbor. The likely repository for these materials is a confined aquatic disposal (CAD) cell, to be installed within the harbor. While the USACE is responsible for the maintenance dredging of the channel, the design and installation of the CAD cell for disposal of the dredged materials will require an approximately 35% local cost share, which is estimated to be approximately $7,700,000.

As part of the DMMP planning, the USACE conducted an economic analysis of activities within the harbor and evaluated the tonnage and total vessel trips that occur within the harbor, and how those economic activities are impacted by channel depths. Based on its analysis, MME was informed that the USACE had justification to conduct maintenance dredging activities to a depth of -33 feet MLLW. Should a non-federal entity desire to have the channel dredged to a depth of -35 feet MLLW, the cost for that additional dredging would be borne re in its entirety by the non-federal entity (i.e., the State).

[33] https://www.nae.usace.army.mil/Portals/74/docs/Navigation/CT/BRH/CT_26_BRH_20200709_CS_033_r.pdf

In order to evaluate the cost/benefits of the additional dredging, MME utilized publicly available data, including the USACE's latest 2020 channel conditions survey, to prepare a rough estimate of what it would take to dredge the additional two feet of sediments to result in a -35-foot MLLW channel. This is not to be considered an engineering design estimate as there are several factors that were not available, including channel slopes, daylights, and the precise limits of the federal navigation project; however, it is meant as demonstration to show cost considerations within a level of magnitude.

Using the USACE's bathymetric data, MME prepared a color-relief bathymetric plan to show the areas that are shallower than -33 feet MLLW (will be dredged by USACE), between -33 feet and -35 feet MLLW (would not be dredged by the USACE) and deeper than -35 feet MLLW (no need for dredging). For the analysis, MME reviewed the areas shallower than -33 feet and between -33 feet and -35 feet, as these would be areas that would need to be addressed as part of the additional dredge program.

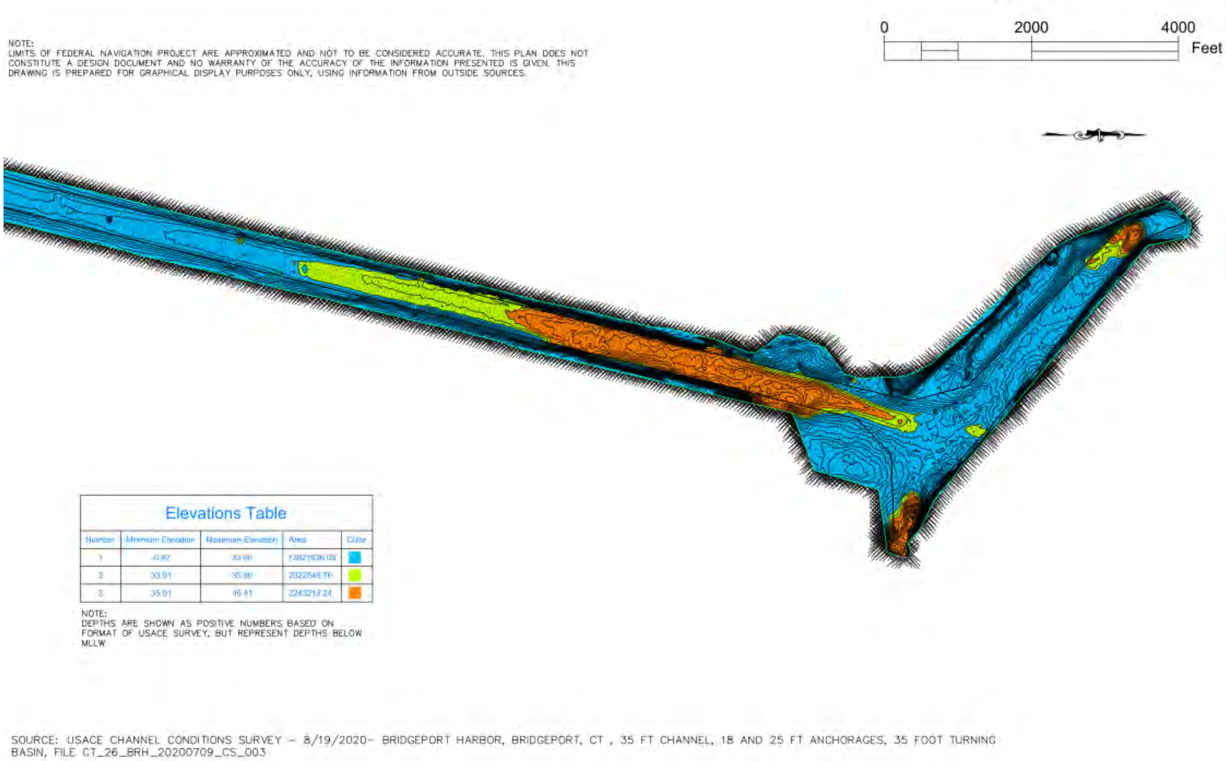


Figure 38 – Color relief display of Bridgeport Harbor Channel Bathymetry

Of the roughly 10,000,000 square feet, 35-foot-deep channel, there is approximately 7,800,000 square feet of the channel that would need to be dredged from -33 feet to -35 feet, which would generate in the order of 575,000 cy of additional sediments to be dredged. Then next step in our analysis was to evaluate the two cost elements of the dredge program:

1. Improvement dredging to create more CAD cell space to receive the unsuitable sediments.
2. Maintenance dredging not conducted by the USACE of the unsuitable sediments and disposal of those sediments within the CAD.

The 2010 draft DMMP plan from the USACE estimated CAD cell creation would cost approximately $16/cy, which MME adjusted to a dredge cost of $20/cy. For the maintenance dredging, since it is over a large area and a more precise operation, MME estimated the maintenance dredging and disposal would cost $30/cy. Based on the areas identified from the bathymetric map, MME estimates that it would cost approximately $11,500,000 to create the additional CAD cell space and an additional $17,250,000 for the maintenance dredging and disposal into the CAD cell, for a total cost of $28,750,000 that would not be covered by the USACE dredging program.

With the project cost consideration developed, MME then evaluated the OSW vessels that would likely be calling on Bridgeport Harbor and evaluate how the two channel target depths would potentially affect their future operations in the harbor. Specifically, MME reviewed WTIVs, as they typically have the deepest draft the OSW vessels that would call on a port. Vessels such as the Brave and Bold Tern from Fred Olsen Windcarriers and the SeaJacks Scylla, typically draft from 8 meters to 9.5 meters (26 feet to 31 feet) and cable-laying vessels such as the Leonardo Da Vinci from the Prysmian group, draft approximately 8 meters (26 feet).

MME discussed these depths and potential vessels with Park City Wind to evaluate if there were any additional vessels that should be included in this evaluation. Park City Wind indicated that they were operating under the assumption of maximum vessel drafts of between 9 meters and 9.5 meters (29.5 feet to 31 feet). Therefore, to support future anticipated OSW operations, MME did not identify supporting justification for the additional dredging (to -35 feet MLLW within the harbor and, as noted in the recommendations section, have identified more effective investments for dredging in Bridgeport Harbor.

4.6.1. Barnum Landing

As discussed above, the current owner of this property was not contacted as part of this analysis.

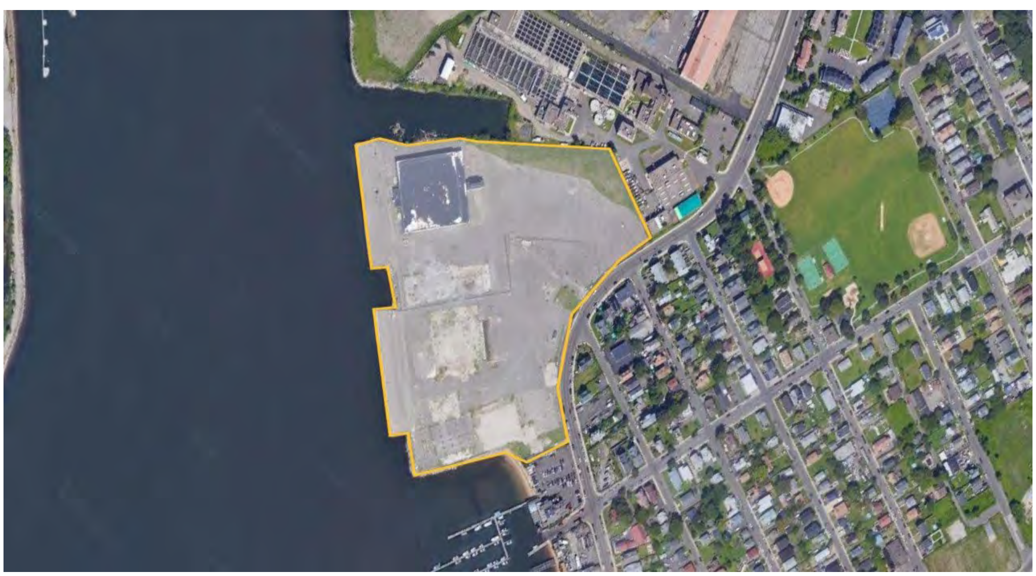


Figure 39 Barnum Landing Site

SITE SUMMARY CARD: Barnum's Landing

	ATTRIBUTE	INFORMATION	NOTES
LOCATION	Municipality:	Bridgeport	
	County:	Fairfield County	
	Port Governance/Security:	Bridgeport Police	Also: Bridgeport Harbor Master
	Distance to Shipping Channel:	600 ft (182.88)	
	Distance to Open Ocean:	2.43 nm (4.5km)	
	Distance to Wind Lease Areas:	115 nm	
	Overhead Restrictions:	None	
	Channel Dimensions (width):	1,250 ft (381m)	
	Channel Depth:	35 ft (10.67m)	
	Distance to Major Roadway:	2,400 ft	I-95
	Distance to Rail connection:	NA	
	Navigational Restrictions/ Considerations:	None	
USE CLASSIFICATION	Ownership (Private v. Public):	private	
	Zoning Classification:	Industrial	
	Neighborhood Type:	Commercial/Industrial	Residential/Commercial Surrounding.
	Proximity to Non-Industrial Use:	700 ft	
	Environmental Restrictions:	None	
CHARACTERISTICS	Total Acreage:	18.5 ac	
	Open Acreage:	18.5 ac	
	Acreage covered by Structures:	Approximately 1.2 ac	
	# Buildings Onsite:	1	
	Acreage of Paved Area:	approximately17 ac	
	Acreage Available for OSW Uses:	Approximately 17 ac	
	Upland Bearing Capacity:	10,000 psf	

SITE SUMMARY CARD: Barnum's Landing

	ATTRIBUTE	INFORMATION	NOTES
WATERSIDE INFRASTRUCTURE	Quayside – Type:	Wharf	
	Quayside Length:	800 ft	
	Wharf Construction:	None	
	Quayside – Condition:	good	
	Quayside Bearing Capacity:	NA	
	Cranes:	None	
	Berth – Depth:	35 ft	
	Berth – Length:	150 ft	
	Berth – Width:	35 ft	
	Berth – Substrate:	Sand & silt	
	Fendering – Type:	rubber	
	Fendering – Condition:	Good	
	Utilities Available at Berth:	None	

Table 21 Site Summary Card Barnum Landing

Notes:

1. Load bearing capacity estimated through engineer assumption without direct testing. Capacity information not available.
2. Information compiled from public records.

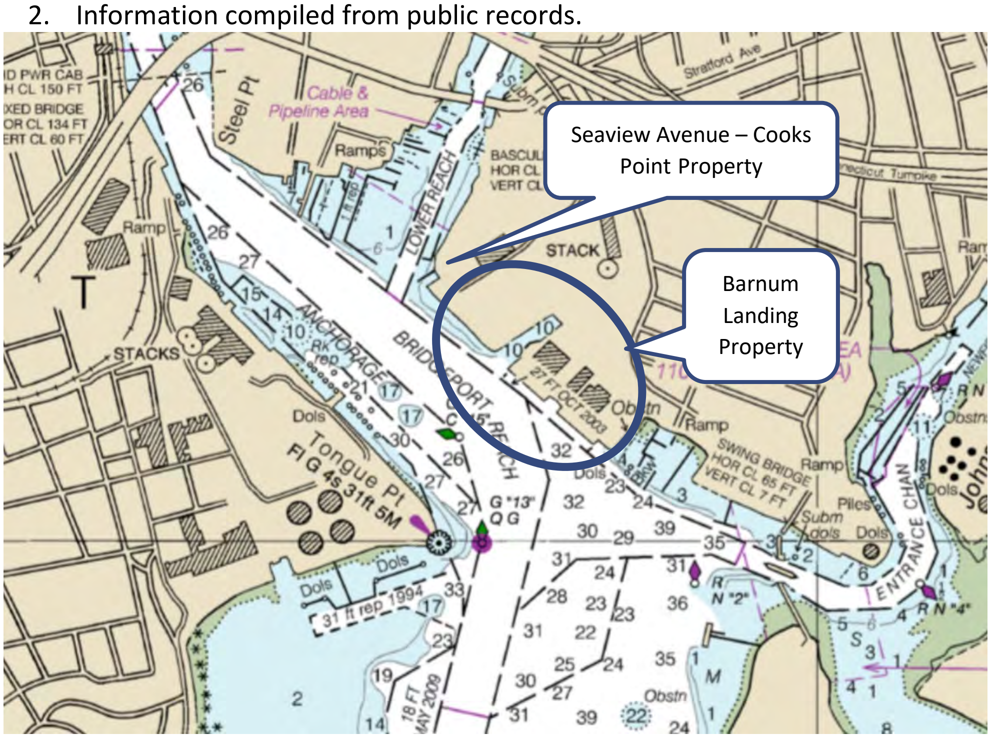


Figure 40 – NOAA Chart – Bathymetry Map of the Barnum Landing Area

Potential CT Offshore Wind Marshalling / Manufacturing Port

Barnum Landing	Bridgeport, CT	18.3 acres	74,057 m^2

Former Shipyard	Harbor Setting	17.8 Useable Acres	72,034 m^2	
Quay Upgrades Needed = Y	2 Quays (each 400-ft / 122-m)	Dist. Open Ocean = 1 nm		
Berth/Channel Depth = 32 ft / 10 m (some shallower shoals)	Channel Width = 400 ft / 122 m	Distance to WEA = 135 nm		
Upland Ground Condition = 750 psf / 3.7 tsm	Upland Surface = Paved	Bridge Air-draft Restrictions = None		
Private Owner	Property can be Subdivided = Y	Sikorsky Airport = 1.66 mi	Contamination = Mod.	Upgrade Costs for OSW = Moderate

Figure 41 - Barnum Landing Key Highlights

Rendering of Barnum Landing Offshore Wind Marshalling Facility

Figure 42 Rendering of Barnum Landing Marshalling Facility

4.6.2. Seaview Avenue

As discussed above, the current owner of this property was not contacted as part of this analysis.

Figure 43- Seaview Avenue – Cooks Point

SITE SUMMARY CARD: Cooks Point (Seaview Ave)			
	ATTRIBUTE	INFORMATION	NOTES
LOCATION	Municipality:	Bridgeport	
	County:	Fairfield County	
	Port Governance/Security:	Bridgeport Police	Also: Bridgeport Harbor Master
	Distance to Shipping Channel:	500 ft (152.4m)	
	Distance to Open Ocean:	2.43 nm (4.5km)	
	Distance to Wind Lease Areas:	115 nm	
	Overhead Restrictions:	None	
	Channel Dimensions (width):	1,200 ft (365.76m)	
	Channel Depth:	35 ft (10.67m)	
	Distance to Major Roadway:	2,600 ft	I-95
	Distance to Rail connection:	NA	
	Navigational Restrictions/ Considerations:	None	
USE	Ownership (Private v. Public):	private	
	Zoning Classification:	Industrial	
	Neighborhood Type:	Commercial/Industrial	Residential/Commercial Surrounding.

	Proximity to Non-Industrial Use:	2,000 ft	
	Environmental Restrictions:	None	
CHARACTERISTICS	Total Acreage:	32 ac	
	Open Acreage:	28 ac	
	Acreage covered by Structures:	approximately4ac	
	# Buildings Onsite:	<5	
	Acreage of Paved Area:	approximately 7 ac	
	Acreage Available for OSW Uses:	approximately28 ac	
	Upland Bearing Capacity:	1,000 psf	

SITE SUMMARY CARD: Cooks Point (Seaview Ave)

	ATTRIBUTE	INFORMATION	NOTES
WATERSIDE INFRASTRUCTURE	Quayside –Type:	pier Wharf	
	Quayside Length:	500 ft	
	Wharf Construction:	None	
	Quayside – Condition:	poor	
	Quayside Bearing Capacity:	NA	
	Cranes:	None	
	Berth – Depth:	35 ft	
	Berth – Length:	150 ft	
	Berth – Width:	35 ft	
	Berth – Substrate:	Sand & silt	
	Fendering – Type:	rubber	
	Fendering – Condition:	Good	
	Utilities Available at Berth:	None	

Table 22 Site Summary Card – Cooks Point (Seaview Avenue)

Notes:

1. Load bearing capacity estimated through engineer assumption without direct testing. Capacity information not available.
2. Information compiled from public records.

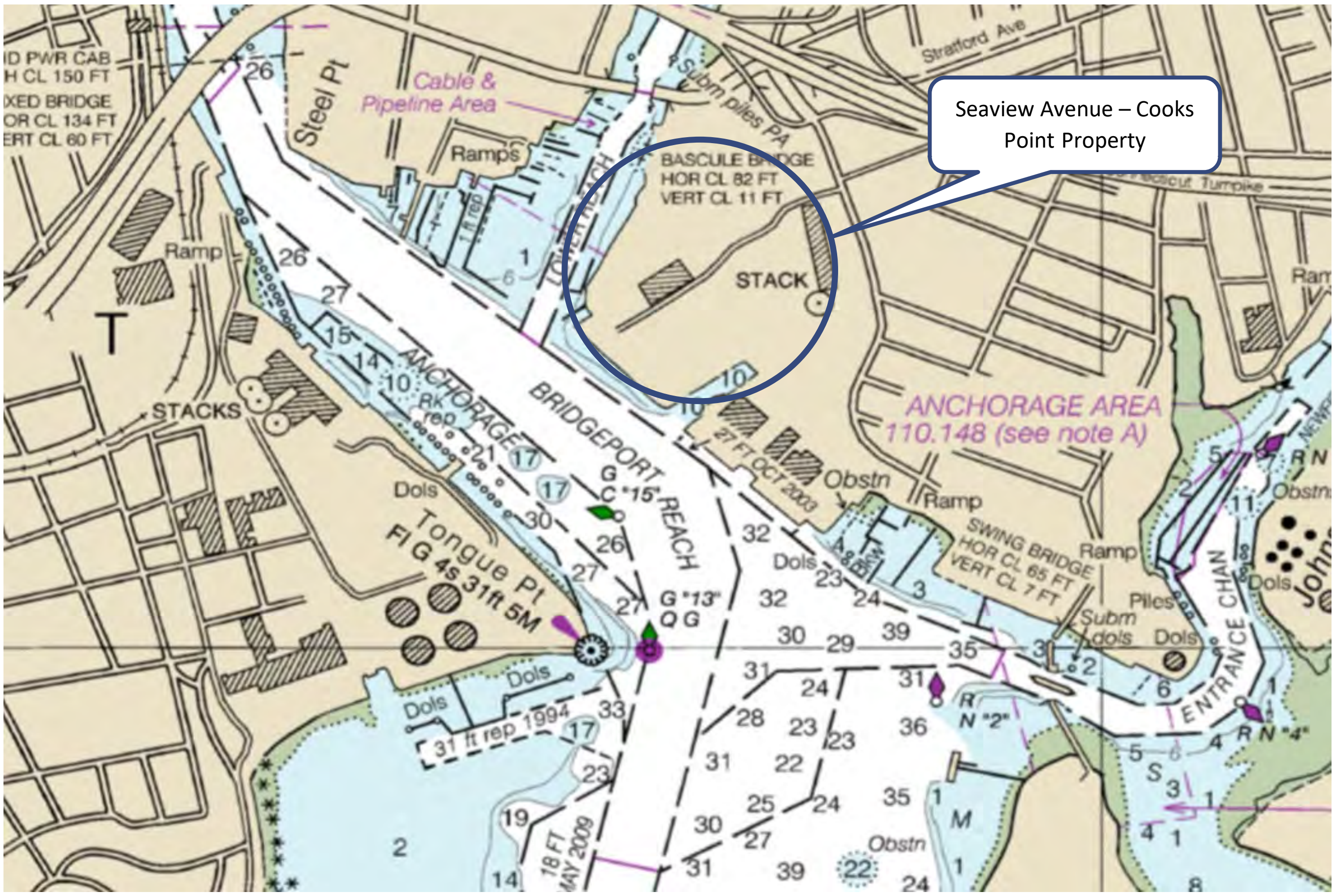


Figure 44 NOAA Chart – Bathymetry Map of the Seaview Avenue – Cooks Point Area

4.6.3. PSEG Power Plant Facility

Please note, these assessments were made independently of any of the property owners and developers, and often without contact or consultation from them. These properties may or may not be available for OSW development, but our inclusion in the report does not imply that they are available for development redevelopment. Our inclusion in this report is only to show that should these facilities became available or show interest in development, then there is potential for use as an OSW facility.

Figure 45 - PSE&G Site Aerial Image

SITE SUMMARY CARD: PG&E Facility

	ATTRIBUTE	INFORMATION	NOTES
LOCATION	Municipality:	Bridgeport	
	County:	Fairfield County	
	Port Governance/Security:	Bridgeport Police	Also: Bridgeport Harbor Master
	Distance to Shipping Channel:	900 ft (274.32m)	
	Distance to Open Ocean:	2 nm (3.7 km)	
	Distance to MA Lease Areas:	115 nm	
	Overhead Restrictions:	None	
	Channel Dimensions (width):	1,225ft (373.38m)	
	Channel Depth:	17-30ft	
	Distance to Major Roadway:	>1 mile	I-95
	Distance to Rail connection:	>1 mile	

	Navigational Restrictions/ Considerations:	None	
USE CLASSIFICATION	Ownership (Private v. Public):	private	
	Zoning Classification:	Industrial	
	Neighborhood Type:	Residential	Residential/Commercial Surrounding.
	Proximity to Non-Industrial Use:	1000 ft	
	Environmental Restrictions:	Unknown	
CHARACTERISTICS	Total Acreage:	40 acres	
	Open Acreage:	~14 acres	
	Acreage covered by Structures:	~10 acres	
	# Buildings Onsite:	<10	
	SF of Building Space:	TBD	
	Acreage of Paved Area:	~40	
	Acreage Available for OSW Uses:	~40	
	Upland Bearing Capacity:	1,000 psf	

SITE SUMMARY CARD: PG&E Facility			
	ATTRIBUTE	**INFORMATION**	**NOTES**
WATERSIDE INFRASTRUCTURE	Quayside –Type:	Dock	
	Quayside Length:	400 ft (121.92 m)	
	Wharf Construction:	None	
	Quayside – Condition:	poor	
	Quayside Bearing Capacity:	TBD	
	Cranes:	None	
	Berth – Depth:	~17 ft	
	Berth – Length:	~300 ft	
	Berth – Width:	~300 ft	
	Berth – Substrate:	Sand & Silt	
	Fendering – Type:	NA	
	Fendering – Condition:	NA	
	Utilities Available at Berth:	None	

Table 23 - Site Summary Card - PSE&G Site

Notes:

1. Load bearing capacity estimated through engineer observation without direct testing. Capacity information not available.
2. Information provided through public records review.

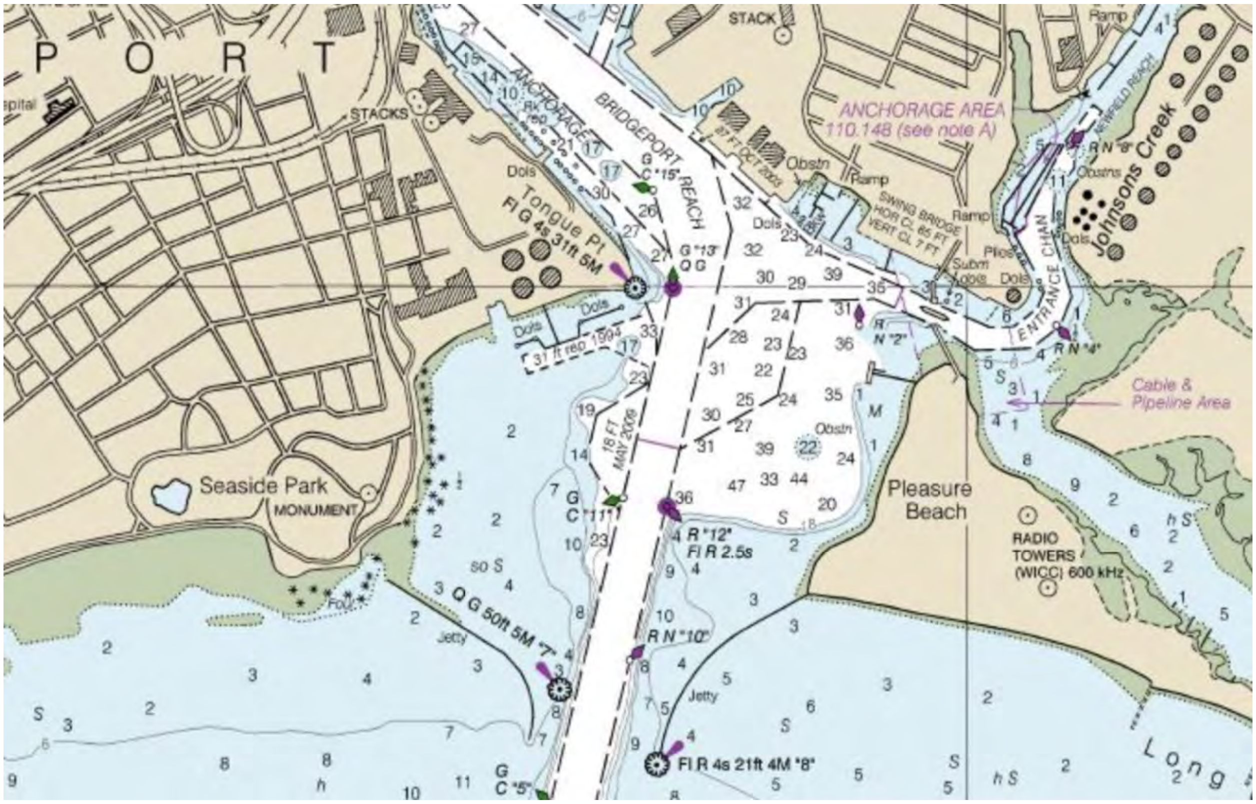


Figure 46 - NOAA Bathymetry Map - PSE&G Site

4.6.4. Stratford Army Engine Plant

As discussed above, the current owner of this property was not contacted as part of this analysis.

Figure 47: Stratford Army Engine Plant

SITE SUMMARY CARD: Stratford Army Engine Plant			
	ATTRIBUTE	**INFORMATION**	**NOTES**
LOCATION	Municipality:	Stratford	
	County:	Fairfield County	
	Port Governance/Security:	Stratford Police	Also: Stratford Harbor Master
	Distance to Shipping Channel:	1,500 ft (457.2 m)	
	Distance to Open Ocean:	2. nm	
	Distance to Wind Lease Areas:	~110 nm	
	Overhead Restrictions:	None	
	Channel Dimensions (width):	1,200 ft (366 m)	
	Channel Depth:	14 ft (4.27 m)	
	Distance to Major Roadway:	2 mi	I-95
	Distance to Rail connection:	NA	
	Navigational Restrictions	None	
USE CLASSIFICATION	Ownership (Private v. Public):	private	
	Zoning Classification:	Industrial	
	Neighborhood Type:	Industrial	
	Proximity to Non-Industrial Use:	2,500 ft	
	Environmental Restrictions:	None	
CHARACTERISTICS	Total Acreage:	77 ac	
	Open Acreage:	77 ac	
	Acreage covered by Structures:	approximately70 ac	
	# Buildings Onsite:	<5	
	Acreage of Paved Area:	approximately7 ac	
	Acreage Available for OSW Uses:	approximately77 ac	
	Upland Bearing Capacity:	1,000 psf	

SITE SUMMARY CARD: Stratford Army Engine Plant			
	ATTRIBUTE	**INFORMATION**	**NOTES**
WATERSIDE INFRASTRUCTURE	Quayside –Type:	None	Breakwater
	Quayside Length:	NA	
	Wharf Construction:	NA	
	Quayside – Condition:	NA	
	Quayside Bearing Capacity:	NA	
	Cranes:	None	
	Berth – Depth:	14 ft	
	Berth – Length:	NA	
	Berth – Width:	NA	
	Berth – Substrate:	Sand & silt	
	Fendering – Type:	rubber	
	Fendering – Condition:	NA	
	Utilities Available at Berth:	None	

Table 24 Site Summary Card – Stratford Army Engine Plant

Notes:

1. Load bearing capacity estimated through engineer observation without direct testing. Capacity information not available.
2. Information provided by Property Owner or Operator or through public records.

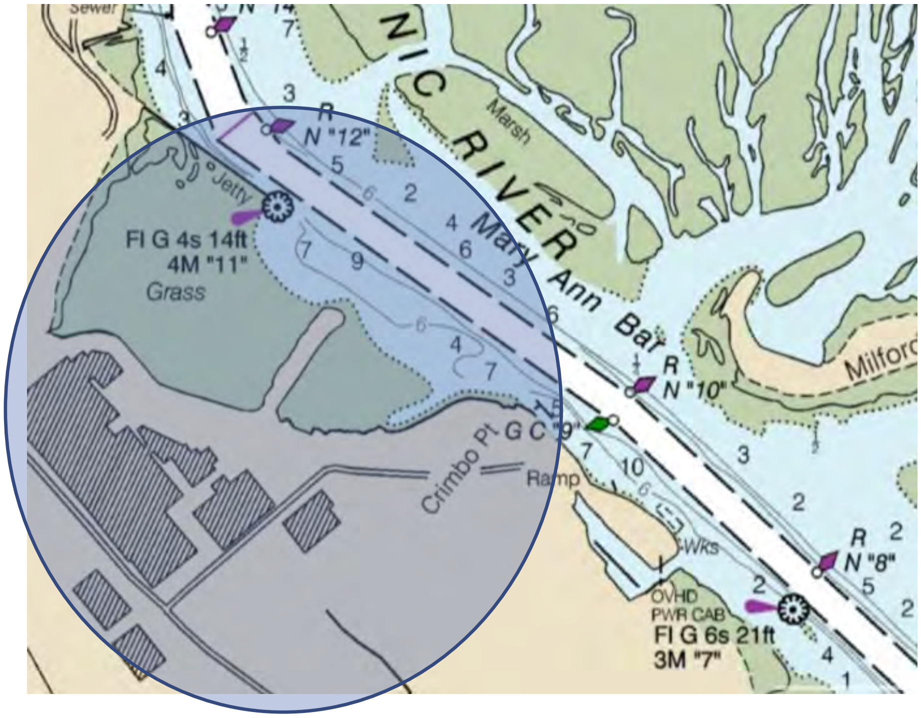


Figure 48: NOAA Chart Bathymetry Map of Stratford Army Engine Plant Area

4.7. Port Infrastructure Assessment - New Haven Area

4.7.1. New Haven Terminal

As discussed above, the current owner of this property was not contacted as part of this analysis.

Figure 49 New Haven Terminal

SITE SUMMARY CARD: New Haven Terminal			
	ATTRIBUTE	**INFORMATION**	**NOTES**
LOCATION	Municipality:	New Haven	
	County:	New Haven County	
	Port Governance/Security:	New Haven Police	Also: New Haven Harbor Master
	Distance to Shipping Channel:	500 ft (152.4m)	
	Distance to Open Ocean:	5.01 nm (9.28km)	
	Distance to Wind Lease Areas:	~85 nm	
	Overhead Restrictions:	None	
	Channel Dimensions (width):	2,230 ft (680 m)	
	Channel Depth:	35 ft (10.67m)	
	Distance to Major Roadway:	200 ft	I-95
	Distance to Rail connection:	NA	
	Navigational Restrictions/ Considerations:	None	
USE CLASSIFICATION	Ownership (Private v. Public):	private	
	Zoning Classification:	Industrial	
	Neighborhood Type:	Commercial/Industrial	
	Proximity to Non-Industrial Use:	700 ft	
	Environmental Restrictions:	None	
CHARACTERISTICS	Total Acreage:	220 ac	
	Open Acreage:	approximately 100 ac	
	Acreage covered by Structures:	approximately10 ac	
	# Buildings Onsite:	<15	
	Acreage of Paved Area:	approximately50	
	Acreage Available for OSW Uses:	approximately100	
	Upland Bearing Capacity:	1,000 psf	

SITE SUMMARY CARD: New Haven Terminal			
	ATTRIBUTE	**INFORMATION**	**NOTES**
WATERSIDE INFRASTRUCTURE	Quayside –Type:	Pier 2 Docks Wharf	
	Quayside Length:	Pier-750 ft Docks-300 ft Wharf-225 ft	
	Wharf Construction:	Unknown	
	Quayside – Condition:	good	
	Quayside Bearing Capacity:	2,000 psf	Assumed based on current activity
	Cranes:	None	
	Berth – Depth:	36 ft	
	Berth – Length:	approximately700 ft	
	Berth – Width:	190f t	
	Berth – Substrate:	Sand & silt	
	Fendering – Type:	rubber	
	Fendering – Condition:	Fair	
	Utilities Available at Berth:	None	

Table 25 Site Summary Card New Haven Terminal

Notes:

1. Load bearing capacity estimated through engineer observation without direct testing. Capacity information not available.
2. Information provided by Property Owner or Operator or public records.

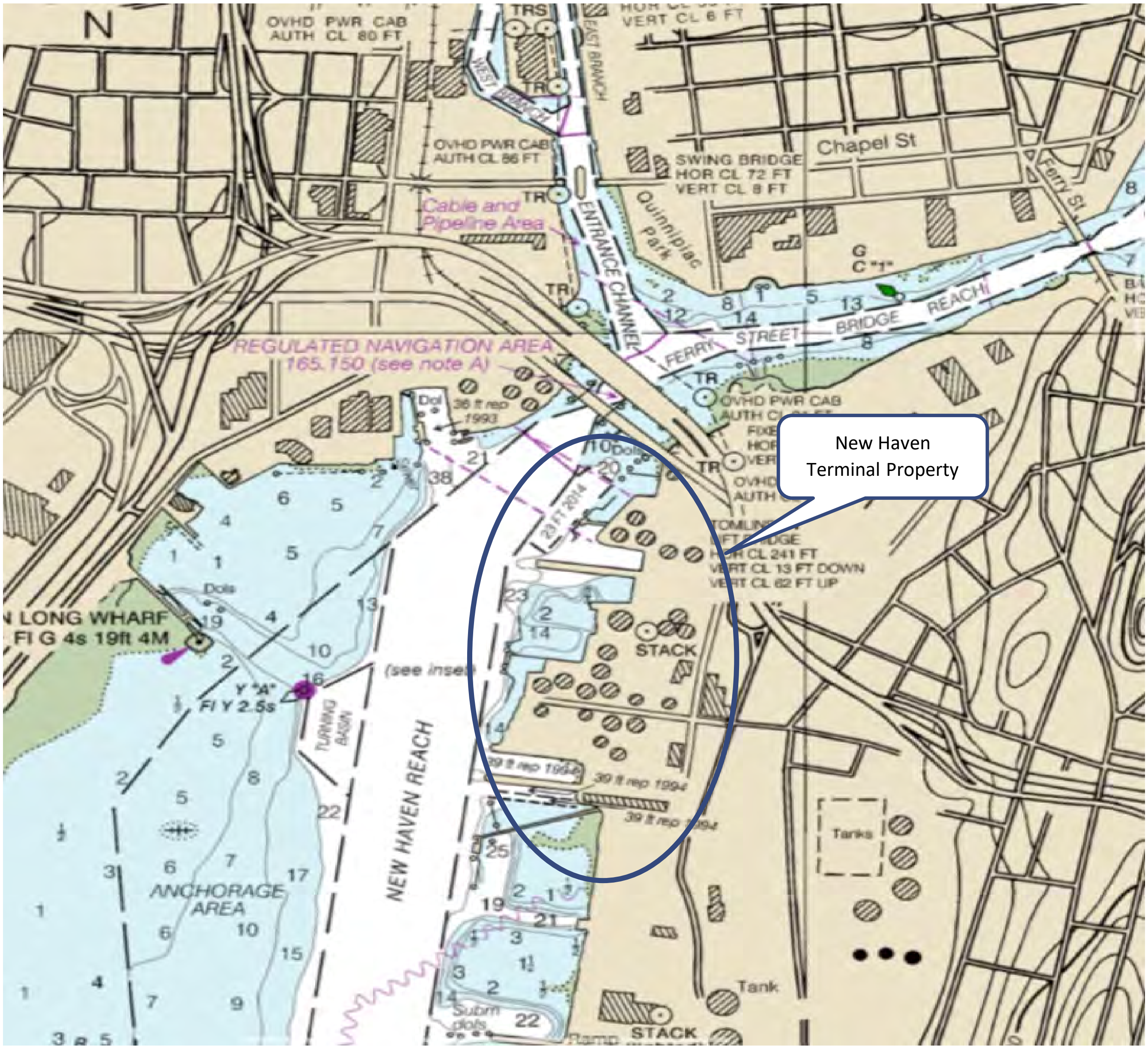


Figure 50: NOAA Chart Bathymetry Map of the New Haven Terminal area

4.7.2. Branford Town Marina

As discussed above, the current owner of this property was not contacted as part of this analysis.

Figure 51 Branford Marina

SITE SUMMARY CARD: Branford Town Marina			
	ATTRIBUTE	INFORMATION	NOTES
LOCATION	Municipality:	Branford	
	County:	New Haven County	
	Port Governance/Security:	Branford Police	Also: Branford Harbor Master
	Distance to Shipping Channel:	600 ft (183 m)	
	Distance to Open Ocean:	2.61 nm (4.83km)	
	Distance to Wind Lease Areas:	80 nm	
	Overhead Restrictions:	None	
	Channel Dimensions (width):	145 ft	
	Channel Depth:	4 ft	
	Distance to Major Roadway:	2 mi	I-95
	Distance to Rail connection:	NA	
	Navigational Restrictions/ Considerations:	None	

USE CLASSIFICATION	Ownership (Private v. Public):	private	
	Zoning Classification:	Commercial	
	Neighborhood Type:	Residential	Residential/Commercial Surrounding.
	Proximity to Non-Industrial Use:	900 ft	
	Environmental Restrictions:	None	
CHARACTERISTICS	Total Acreage:	12 ac	
	Open Acreage:	approximately11 ac	
	Acreage covered by Structures:	approximately2 ac	
	# Buildings Onsite:	10	
	Acreage of Paved Area:	approximately8 ac	
	Acreage Available for OSW Uses:	approximately10 ac	
	Upland Bearing Capacity:	1,000 psf	

SITE SUMMARY CARD: Branford Town Marina			
	ATTRIBUTE	**INFORMATION**	**NOTES**
WATERSIDE INFRASTRUCTURE	Quayside –Type:	Dock	
	Quayside Length:	730 ft	
	Wharf Construction:	None	
	Quayside – Condition:	Good	
	Quayside Bearing Capacity:	TBD	
	Cranes:	None	
	Berth – Depth:	8 ft	
	Berth – Length:	700 ft	
	Berth – Width:	approximately8 ft	
	Berth – Substrate:	Sand & silt	
	Fendering – Type:	TBD	
	Fendering – Condition:	NA	
	Utilities Available at Berth:	None	

Table 26: Site Summary Card Branford Marina

Notes:

1. Load bearing capacity estimated through engineer observation without direct testing. Capacity information not available.
2. Information provided by Property Owner or Operator or through public records.

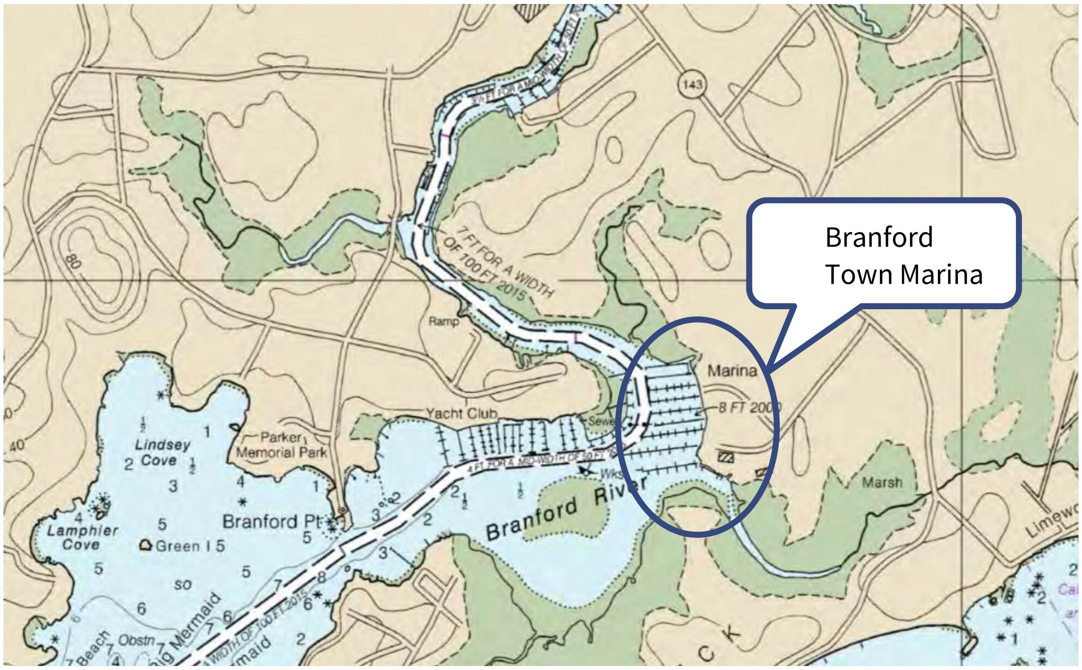


Figure 52: NOAA Chart Bathymetry Map of the Branford Town Marina Area

4.8. Major Port Facilities Site Specific Port Redevelopment Options

4.8.1. Barnum Landing Port Facility Reuse Scenarios

Figure 53: O&M Senario Barnum Landing

Figure 54 Secondary Steel Scenario

Figure 55 Transition Piece Storage Scenario

4.8.2. Cost Considerations for Barnum Landing Site Reuse Scenarios

Barnum Landing - Bridgeport, CT
OSW Port Redevelopment

Redevelopment Scenario	Item	Unit Costs	Units	Quantity	Amount
Transition Piece Storage	Install 2 ft DGA for Laydown Area	$16	sf	120,000	$1,920,000
	Soil Mixing	$12	sy	13,333	$160,000
	Building Demolition	$10	sf	55,000	$550,000
	Heavy Duty Quayside	$40,000	lf	400	$16,000,000
	Concrete Relieving Platform	$25	sf	60,000	$1,500,000
	Stormwater Utilities	$20	sf	40,000	$800,000
	Office Building / Warehouse	$30	sf	135,000	$4,050,000
	Perimeter Security Fencing	$80	lf	2,600	$208,000
	Berth Dredging	$100	cy	10,000	$1,000,000
	Jackup pad installation	$85	cy	2,000	$170,000
	Parking _Asphalt	$8	sf	40,000	$320,000
	Subtotal				**$26,678,000**
	20% Contingency				**$5,335,600**
	Total				**$32,013,600**
Secondary Steel Fabrication	Install 2 ft DGA	$16	sf	140,000	$2,240,000
	Soil Mixing	$12	sy	15,556	$186,667
	Building Demolition	$10	sf	55,000	$550,000
	Update Quayside	$24,000	lf	400	$9,600,000
	Stormwater Utilities	$20	sf	34,000	$680,000
	Office Building	$30	sf	25,000	$750,000
	Warehouse	$24	sf	120,000	$2,880,000

	Perimeter Security Fencing	$80	lf	2,600	$208,000
	Parking _Asphalt	$8	sf	40,000	$320,000
	Subtotal				**$17,414,667**
	20% Contingency				**$3,482,933**
	Total				**$20,897,600**
Operation and Maintenance	Install 2 ft DGA	$16	sf	60,000	$960,000
	Soil Mixing	$12	sy	6,667	$80,000
	Building Demolition	$10	sf	55,000	$550,000
	Update Quayside	$15,000	lf	800	$12,000,000
	Operations Center	$30	sf	60,000	$1,800,000
	Stormwater Utilities	$20	sf	40,000	$800,000
	Parking _Asphalt	$8	sf	40,000	$320,000
	Perimeter Security Fencing	$80	lf	2,600	$208,000
	Warehouse	$24	sf	75,000	$1,800,000
	Subtotal				**$18,518,000**
	20% Contingency				**$3,703,600**
	Total				**$22,221,600**

Table 27 Cost Considerations Barnum Landing Redevelopment

4.8.3. Seaview Port Facility (Former Derektor Shipyard/ Cooks Point) Reuse Scenarios

Figure 57 Cooks Point Storage Port Scenario

Figure 56 Cooks Point O&M Scenario

4.8.4. Cost Considerations for Seaview (Cooks Point) Site Reuse Scenarios

Seaview Avenue - Bridgeport, CT
OSW Port Redevelopment

Redevelopment Scenario	Item	Cost	Units	Quantity	Amount
Storage Port	Install 2 ft DGA for Laydown Area	$16	sf	280,000	$ 4,480,000
	Soil Mixing	$12	sy	31,111	$ 373,333
	Building Demolition	$10	sf	-	$ -
	Improved Quayside	$15,000	lf	500	$ 7,500,000
	Stormwater Utilities	$20	sf	100,000	$ 2,000,000
	Office Building / Warehouse	$30	sf	20,000	$ 600,000
	Perimeter Security Fencing	$80	lf	4,700	$ 376,000
	Dredging	$100	cy	7,500	$ 750,000
	Jackup Pad	$85	cy	2,000	$ 170,000
	Parking _Asphalt	$8	sf	100,000	$ 800,000
	Subtotal				**$ 17,049,333**
	20% Contingency				**$ 3,409,867**
	Total				**$ 20,459,200**
Operation and Maintenance	Install 2 ft DGA	$16	sf	110,000	$ 1,760,000
	Soil Mixing	$12	sy	12,222	$ 146,667
	Building Demolition	$10	sf	-	$ -
	Update Quayside	$15,000	lf	500	$ 7,500,000
	Operations Center	$30	sf	60,000	$ 1,800,000
	Stormwater Utilities	$20	sf	100,000	$ 2,000,000
	Parking _Asphalt	$8	sf	100,000	$ 800,000
	Perimeter Security Fencing	$80	lf	4,700	$ 376,000
	Warehouse	$24	sf	75,000	$ 1,800,000
	Subtotal				**$ 16,182,667**
	20% Contingency				**$ 3,236,533**
	Total				**$ 19,419,200**

Table 28 Cost Considerations Cooks Point Redevelopment

4.8.5. Seaview Port Facility (Cooks Point) Site Plus Barnum Landing Combined Port Facility Reuse Scenario

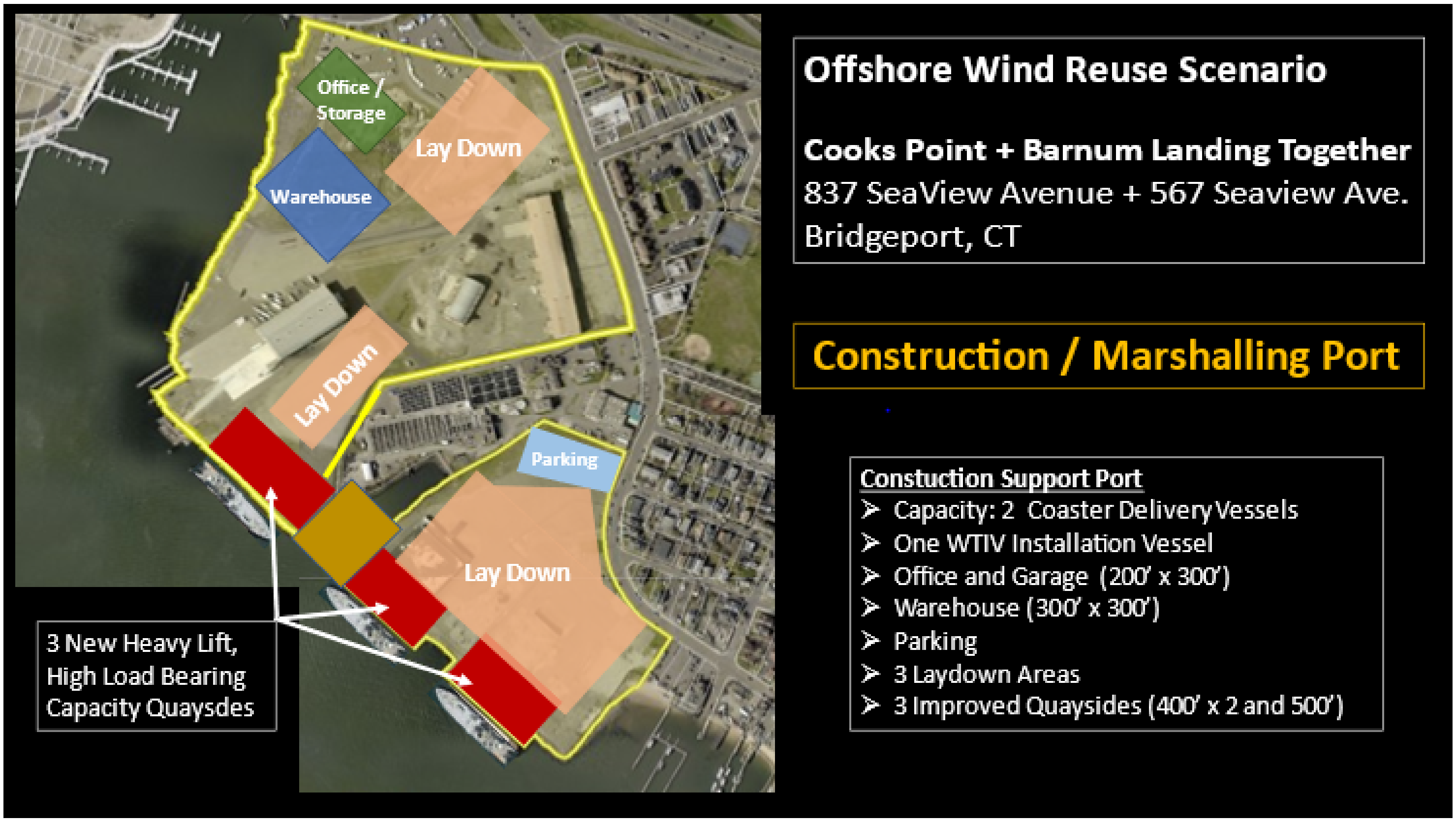


Figure 58 Construction/ Marshalling Port Cooks Point and Barnum Landing

4.8.6. Cost Considerations for Seaview (Cooks Point) and Barnum Landing Combined Site Reuse Scenario

Barnum Landing and Seaview Ave - Bridgeport, CT
OSW Port Redevelopment

Redevelopment Scenario	Item	Costs	Units	Quantity	Amount
Construction/ Marshalling Port	Install 2 ft DGA for Laydown Area	$16	sf	490,000	$ 7,840,000
	Soil Mixing	$12	sy	54,444	$ 653,333
	Building Demolition	$10	sf	55,000	$ 550,000
	Heavy Duty Quayside	$40,000	lf	1,300	$ 52,000,000
	Concrete Relieving Platform	$25	sf	195,000	$ 4,875,000

	Stormwater Utilities	$20	sf	40,000	$ 800,000
	Office Building and Garage	$30	sf	60,000	$ 1,800,000
	Warehouse	$24	sf	90,000	$ 2,160,000
	Perimeter Security Fencing	$80	lf	10,100	$ 808,000
	Berth Dredging	$100	cy	17,500	$ 1,750,000
	Jackup pad installation	$85	cy	6,000	$ 510,000
	Parking _Asphalt	$8	sf	40,000	$ 320,000
	Subtotal				**$ 74,066,333**
	20% Contingency				**$ 14,813,267**
	Total				**$ 88,879,600**

Table 29 Cost Considerations – Cooks Point and Barnum Landing Redevelopment

4.8.7. PSEG Port Facility Reuse Scenario

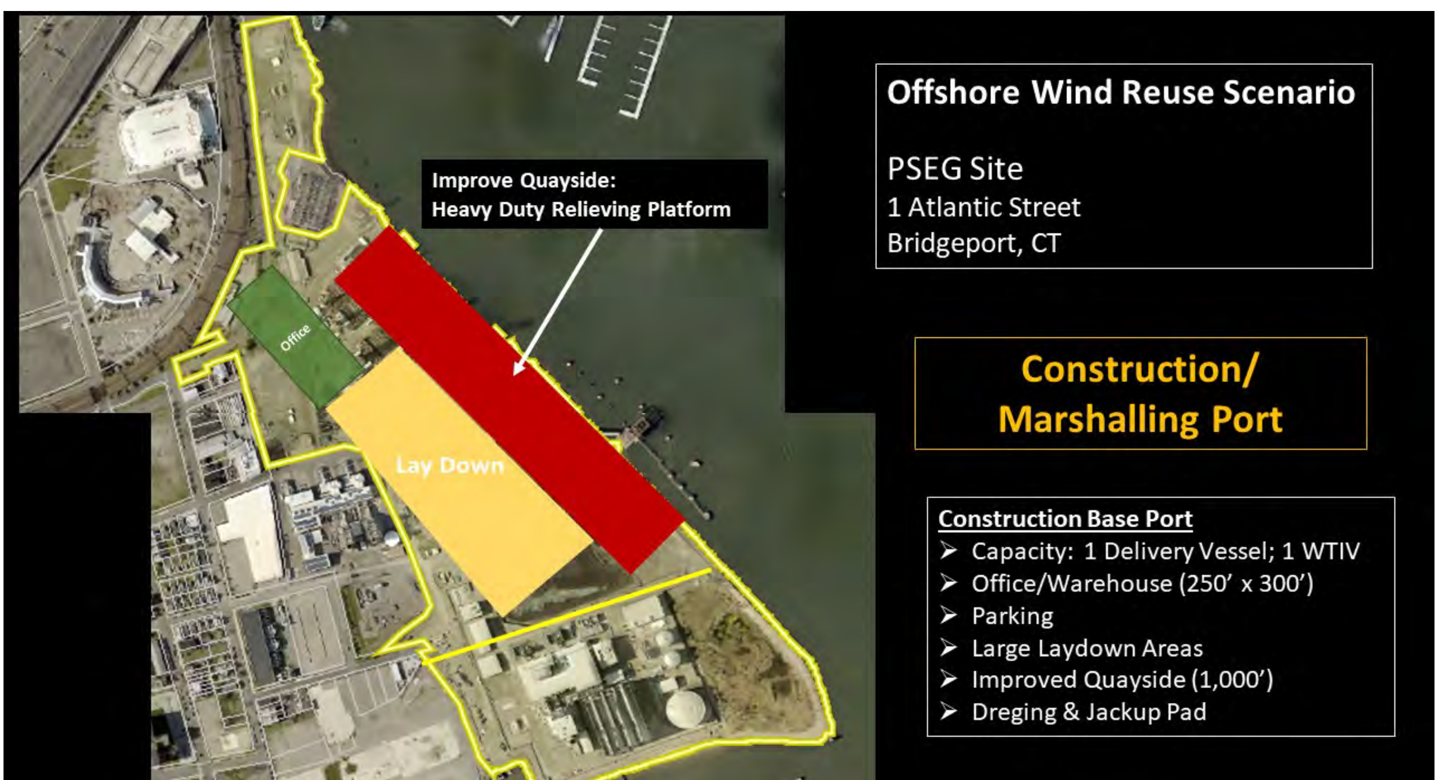


Figure 59 PSEG Facility Construction/ Marshalling Port Redevelopment

PSEG Site - Bridgeport, CT
OSW Port Redevelopment

Redevelopment Scenario	Item	Unit Cost	Units	Quantity	Amount
Construction/ Marshalling Port	Install 3 ft DGA for Laydown Area and Capping	$24	sf	200,000	$4,800,000
	Soil Mixing	$12	sy	22,222	$266,667
	Building Demolition	$10	sf	206,000	$2,060,000
	Heavy Duty Quayside	$40,000	lf	1,000	$40,000,000
	Concrete Relieving Platform	$25	sf	150,000	$3,750,000
	Stormwater Utilities	$20	sf	40,000	$800,000
	Office Building and Garage	$30	sf	75,000	$2,250,000
	Environmental Remediation (*Assume 15% of the developed site)	$55	sf	94,650	$5,205,750
	Perimeter Security Fencing	$80	lf	2,200	$176,000
	Berth Dredging	$100	cy	33,333	$3,333,333
	Jackup pad installation	$85	cy	8,333	$708,333
	Parking _Asphalt	$8	sf	40,000	$320,000
	Subtotal				**$63,670,083**
	20% Contingency				**$12,734,017**
	Total				**$76,404,100**

Table 30 Cost Considerations PSEG Redevelopment

4.9. Considerations for Port Infrastructure

Connecticut holds an enviable position in the OSW industry – its ports are, for the most part, clear of overhead restrictions. The presence of overhead restrictions (i.e., bridges, airport height limitations, and/or City/Town zoning requirements) severely restrict the use of port infrastructure in other states. The OSW industry is highly dependent on infrastructure that fits within the established processes and procedures that the industry has developed in Europe. While this paradigm may slowly shift to American standard industry practices, at this time in the development of the domestic industry there is a strong propensity for OSW developers to follow the European procedures that have developed over the last 20 years and are prevalent in the European market. To the OSW developers, new practices represent a technical risk to their projects, which translates to financial risk to project financiers. Because the U.S. market is driven by low energy costs, in order for the OSW industry to compete with other forms of energy, the LCOE for OSW energy must be competitive or lower than energy produced by other means such as natural gas.

As OSW developers are bidding into a highly competitive U.S. market, they are extremely risk averse. At the same time, the coastline in the U.S. looks very different than European coastlines, and there is a distinct shortage of waterfront properties and/or port facilities that do not have bridge or other height restrictions. This is important because the components being transported, and many of the vessels, are too tall to fit beneath most of the bridges or fit within other height restrictions at many of the ports along the East Coast of the U.S. This means the OSW industry is looking for port facilities that are free of overhead restrictions and as proximal as possible to the OSW installation areas.

The need for port infrastructure without overhead restrictions is currently driven by the vessels and T&I methodologies that the OSW industry prefers – the use of WTIVs for the at-sea installation of the turbines. These massive vessels use very long “legs”, known as spuds, to jack the hull of the vessel off the water surface to provide the ultra-stable platform that is required to install the over-sized wind turbine components. In the European market, the WTIV not only installs the wind turbine components at sea, but also carries the components from the port facilities out to the wind farm installation site. The market there can use that process because most of the port infrastructure that could be adapted for OSW has no bridges (or other overhead restrictions) between the port and the areas of the ocean where the OSW farms are being installed. This is the process that the OSW industry in Europe has undertaken for the installation of the dozens of wind farms that have been erected thus far in Europe. This is also the process that the developer community wants to use in the U.S.

The absence of overhead restrictions means the Ports of Connecticut are likely to play (and are already playing) a key role in the U.S. Offshore Wind industry. This is one of the main reasons that both Ørsted/Eversource and Avangrid are planning on marshalling their Connecticut projects out of Connecticut ports – Ørsted/Eversource from New London and Avangrid from Bridgeport. In both these examples, the ports have relatively deep-water access and no overhead restrictions.

A note about the Jones Act (the maritime law in the U.S. that restricts the use of foreign-flagged vessels when moving cargo between one U.S. port to another U.S. port [or offshore installation such as a wind farm]) is warranted here. At present, there are no Jones Act-compliant WTIV vessels in the industry. One Jones Act WTIV has been ordered by the OSW developer - Dominion (Virginia), and there are signs in the industry that other orders are on the horizon. That WTIV has been secured by Ørsted/Eversource for the deployment of their projects out of State Pier in New London. For other projects, European WTIV vessels have been used (and/or are planned to be used), until such time as the U.S. has more available Jones Act-compliant WTIVs. Until there is an available supply of Jones Act-compliant WTIV s in the U.S., the industry it is anticipated that the use of a “Feeder Vessel” concept that relies on U.S. built, owned, and operated barges that ferry OSW components out to the installation sites at sea.

The number of projects that are likely to move into construction at the same time is growing, and the demand for vessels will likely outstrip the supply of Jones Act-compliant WTIV’s (even as new vessels are built), which is likely to result in a hybrid approach to wind farm installation, with some developers and installation contractors favoring the WTIV installation strategy, whereas others will have adopted to a feeder system and will promote that method for installation. When one considers however, that State ports will have utility regardless of whether a feeder system or the direct WTIV installation approach is used, then it is expected that developers, OEMs, and T&I contractors will look to work out of ports that have the potential to handle WTIV’s eventually, even if the industry is using the feeder concept initially.

All of this adds up to a situation where the few states (such as Connecticut) that have ports that do not have height-restricted transport will benefit. The main challenge for the State then is to facilitate the market to accomplish the following: (1) make industry players aware of the assets that reside in Connecticut; (2) create market conditions through policy, attention, and focused investment in infrastructure to attract the market, and (3) develop a program (through governance or structural amplification of programs) that make the State the place that is most attractive to the industry.

Recommendations: Ports and Related Supply Chain:

Recognize the importance of the ports in the development of the OSW supply chain in the State and include ports representation as part of State Governance refocus on Offshore Wind. Include at least two OSW ports and infrastructure experts on the OSW Governance Committee (see also Recommendations in the Governance segment of this Report). Educate internally (Inside Sales) with State agencies the importance of ports to the OSW industry; and provide an "OSW Concierge" to aggressively market the OSW supply chain (this position in addition to the ports personnel noted above.

Aggressively promote the ports of Connecticut to the OSW industry: Amplify the positive attributes of the multiple port properties) within the State – market the fact that the ports of the State have attributes attractive to the OSW industry. Provide State assistance in the form of marketing advice to the ports, promotion of facilities at State sponsored and/or industry trade gatherings. Generate a united front in the promotion of the Ports of Connecticut through:

- **Education:** Educate and conduct outreach to all potential players in the OSW industry. Educate the industry on the port assets that exist in Connecticut. Develop and provide expert input to panels at various industry technical conferences. Develop with State academic institutions (e.g., UConn, Yale, Quinnipiac, E. Conn, USCGA, UNH, etc.), a program to establish Capstone Projects that focus on the ports of Connecticut as OSW assets. Include representatives of the ports in outreach efforts to the OSW industry. Promote the ports as a key portion of the supply chain for offshore wind.
- **Finance:** Recognize that acquisition of the significant capital financial stack required to conduct the significant port upgrades required by the OSW industry is very difficult for most port owners/operators (particularly at the private ports) to participate in due to the shear amount of funds which will be required.
- **Developing Public/Private Partnerships**: Work with the ports in Connecticut to identify pathways for collaboration via PPPs. This could include incorporation of public interest into a port operation (example – the ports of Rhode Island often incorporate dockage for police and fire boats and/or local ferry to incorporate a public good to assist in Federal grant applications. It could also include partial or full ownership of the ports by the State. Provide expert advice and assistance to the ports in Connecticut (private and public) in the development of Federal grant applications for funding such as U.S. DOT INFRA, RAISE and PIDP-type granting programs.

Promote Regional Collaboration: Establish connections with other states involved in the OSW industry and promote cross-border collaboration of the ports and the supply chain. In particular, promote programs and activities that establishes bi-directional deals using existing industries and port activities in Connecticut (i.e., with established Navy and bridge infrastructure contractors). Negotiate with existing OSW ports in the region (i.e., SBMT in New York, NBMCT in Massachusetts, ProvPort and Quonset in Rhode Island) to provide overflow space, extensions of existing terminals, and attractive material storage situations that encourage the other OSW Ports in the region to set up framework agreements and MSA's with Connecticut Ports. Another example of other states promoting regional collaboration is a recent memorandum of understanding (MOU) between Maryland, Virginia, and North Carolina to develop a Southeast States OSW Coalition.

Integrate OSW into the overall manufacturing scene within the State. Provide direct and frequent connections and collaborations with the State manufacturers associations and other relevant manufacturing trade and economic development organizations to educate their membership in the opportunities available in OSW and provide and encourage direct connections for State suppliers, the ports, and OSW developers with component and service suppliers. This could include participating in non-OSW trade shows and conferences to more effectively "*fly the offshore wind flag*."

Streamline, clarify, and amplify State incentive packages that manufacturers and service providers in the OSW industry can enjoy if they commit to working with a Connecticut port to build OSW manufacturing capacity in Connecticut. Conduct a full review of all of the economic incentives, financial support, and finance structuring (i.e., Rhode Island has provided significant tax relief packages to ports that have the potential for creating local employment – the private port of East Providence received a $15 million tax relief package to assist with the financial development of the port – that funding leveraged private investment in the port for OSW as financiers saw the state back the port because of its involvement in OSW).

Once a review of all potential incentive packages has been completed, develop a clear, concise, yet comprehensive industry-specific **Guide to Financial Incentives for the OSW** Industry for ports and factory development for potential manufacturers and service providers. Conduct direct outreach and marketing to the Tier 1 and Tier 2 OSW manufacturers. Amplify the potential to leverage the already existing industry players in the aerospace and marine technology in Connecticut.

Incentivize existing manufacturers, suppliers, and service providers in similar industries in the State to team and partner with the ports of Connecticut to create OSW manufacturing or fabrication capacity along the waterfront in the State and/or the region. Encourage OSW port clusters. Make it clear to the OSW suppliers and developers that there is a willing and highly skilled secondary and tertiary manufacturing capacity in Connecticut that is connected to the State ports and land-side areas. Create a fund that existing manufacturers can tap into to buy equipment, develop local presence, and team with port entities to create presence in the ports and increase the ports attractiveness to the OSW industry. Focus on both OSW component manufacturing and fabrication and services. Create a comprehensive program to identify and promote port services and related products (maritime services and products) to the potential OSW Ports in the State.

Assist potential OSW ports with certifications, training, and regulatory program development for the OSW industry. Programs such as MARSEC (US Coast Guard Maritime Security) Port Plan development and implementation, security programs and requirements, and HSE program development can be overwhelming to port owners and operators. Provide assistance to the ports in the development, implementation, and operations and maintenance of programs. OSW developers, OEMs, and manufacturing entities prefer to deal with sophisticated and advanced programs and will respond positively if port personnel have been trained in the elements of running and operating an OSW port that are unique to the OSW industry. Recommend creating a fund (one that might escalate over time as the industry needs develop) for training, investment in training programs and facilities, and for assistance with the development of plans and programs within the ports.

Assist with dispute resolution between port operations involved in OSW and other users and industries resident within the ports. Conduct a *conflict assessment* of all the ports that may become involved in the OSW industry. Develop an *OSW Port Harmony Plan* which provides mitigatory action for potential use conflicts within the port included within the plan. For example, the Port of New Bedford in Massachusetts has developed a plan to lessen conflict between the traditional maritime industries in the port and the offshore wind industry which anticipates using the port extensively. The plan involved adding infrastructure (such as spudded barges for the berthing of other industry vessels to lessen congestion on piers where OSW vessels are expected to berth).

Create a mechanism to fund grants to the Ports for OSW development. Following the example of New York State, where NYSERDA provided grant funds for port facility upgrades as a match to developer investment in the ports, Connecticut could provide grant funds for port development for OSW. This will both encourage investment from developers, OEMs, manufacturers, and the supply chain to land operations in the State. This will also leverage both federal grant funds (make it easier for ports to acquire a portion of their financial stack from federal grant programs) and private investment in the ports and in the State's supply chain.

Create an Offshore Wind Solicitation program that requires investment in port infrastructure. Similar programs in New York, New Jersey, and Maryland require developers bidding to supply power through the State's procurement process to investment in the State's supply chain and/or ports to win a PPA. While this may result in a marginal increase in the cost of power, it forces the development of port infrastructure and encourages the development of a local supply chain.

5. Supply Chain

The following provides a discussion of the specific capabilities and opportunities associated with Connecticut's early -entry and on-going/long-term participation in the U.S. and international OSW supply chain.

5.1. Existing Capabilities within Connecticut

One of Connecticut's greatest strengths is its existing and organic manufacturing assets which are more than fully capable of attracting, growing, and retaining OSW supply chain entities, including:

- General manufacturing capabilities;
- Aerospace and maritime manufacturing capabilities; and,
- Advanced technologies and manufacturing.

5.1.1. General Manufacturing

According to the National Association of Manufacturers (NAM)[34], manufacturers in Connecticut account for 11.23 percent of the total output in the State and employs 9.50 percent of the workforce. Total output from State manufacturing assets was $30.78 billion in 2018 and there was an average of 161,000 manufacturing employees in the State in 2019, with an average annual compensation of $98,150.10 in 2018.

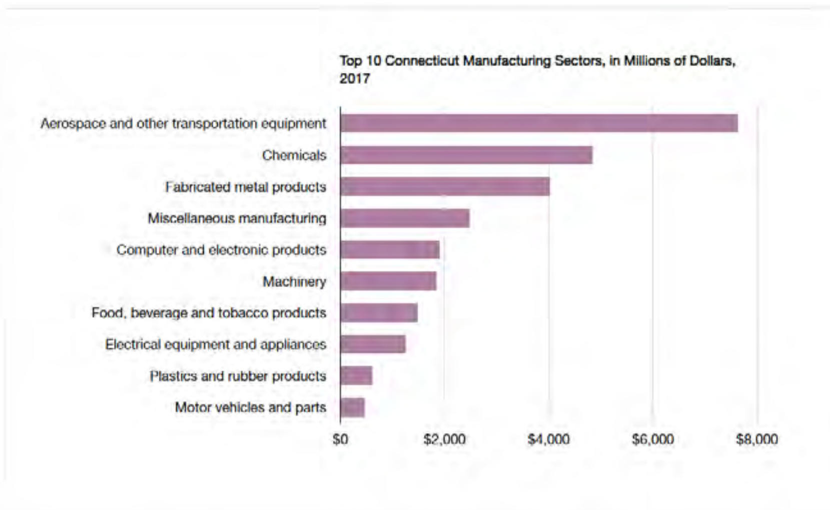


Figure 60 Summary of State Manufacturing Sectors in 2017 (source: NAM)

As illustrated in the adjacent figure, the three primary State manufacturing sectors are aerospace, chemicals, and fabricated metal products. The overall extensive and diverse nature of Connecticut's manufacturing sectors is a strong asset to support the State in participating in the supply chain for the developing U.S. OSW market. The very diverse nature will allow the State to support the needs of the OSW OEMs This ability and anticipated successful responses to early-mover projects procurements will prove to the European developers and OEMs that Connecticut's manufacturing assets are fully capable of supporting their projects both in the short term and into the foreseeable future, which will give them confidence that Connecticut will be an effective, long-term player in the marketplace.

[34] (https://www.nam.org/state-manufacturing-data/2020-connecticut-manufacturing-facts/)

As previously stated, the ability to respond rapidly to early enquiries from OEMs will play a critical role in Connecticut's entrée into this market. State manufacturers who are already manufacturing fabricated products for other markets will have a significant advantage over European-based manufacturers looking to anchor new operations in Connecticut and the U.S. A good local example of this type of firm is Mohawk NE. They are already providing maritime services in the region and have a shop to fabricate metal components for their varied types of projects located in Connecticut, New York, Massachusetts, and Rhode Island. They are already in the process of installing a quay wall, pier, and associated uplands area to support their fabrication portion of the business. As the OSW supply-chain starts to evolve, Mohawk NE plans to aggressively pursue the marketplace by leveraging their existing metal-fabrication capabilities coupled with their ability to trans-ship completed components from their facility to the customer's job sites. Their fabrication facility is also located adjacent to the New London State Pier facility (the two properties are currently divided by a chain-link fence) which could readily allow for inter-facility movement of completed components by SPMTs. Mohawk NE also had room at their fabrication facility to expand operations. As such, they are fully ready to support all stages of the OSW supply-chain marketplace as it evolves over time. It should also be noted that their business is not currently dependent upon entering into the OSW market, thereby de-risking their entrée into the industry.

Figure 62 Example of a Mohawk NE barge/crane unit supporting operations at EB.

Figure 61 Interior view of Mohawk NE's fabrication facility

5.1.2. Aerospace and Maritime

The primary maritime manufacturing industry in Connecticut is focused on the General Dynamics Electric Boat facility located on the east bank of the Thames River in Groton. The aerospace industry is wide-spread throughout the State primarily centered on the I-95 corridor.

Aerospace Manufacturers

Connecticut has a long and rich history of supporting the aviation and aerospace industries in both the 20th and 21st Centuries. This has led to the development of a large, multi-facetted manufacturing supply chain. Although there are some overlaps with the EB maritime supply chain discussed below, in general, the aerospace supply chain in an entity unto itself.

According to the Connecticut Department of Economic and Community Development (DECD), "*as both a pioneer and a global leader in aerospace and defense, Connecticut is home to "Aerospace Alley," an industrial ecosystem of thousands of advanced manufacturing companies drawing from the fifth most productive workforce in America*." State economic resources indicate that over 1,000 aerospace manufacturers and component firms make their home in Connecticut, in part due to the following:

- **The State's Investment in Advanced Manufacturing**: The $75 million Connecticut Manufacturing Innovation Fund (CMIF) encourages company/university R&D collaboration, finances workforce training and offers matching funds for federal grants. This is a State economic incentive program which frontloads rewards and funds to entities looking to enter this high-tech marketplace.
- **Highly skilled, productive workforce**: Connecticut's aerospace and defense worker productivity is ranked third in the U.S. The State is populated by highly motivated and skilled workers who have proven time and time again that they know how to get the job done.
- **Reputation for innovation**: Connecticut innovators hold 51% more patents per capita than the national average. This means that Connecticut is home to smart and entrepreneurial people who represent an invaluable resource both to the aerospace industry as well as the developing OSW supply chain.
- **National Leader in Defense**: Connecticut manufacturers bring in nearly $12 billion in defense contracts. This level of work results in a deep and reliable supply chain that is fully capable of pivoting to provide services to the OSW supply chain.
- **Industry Knowledge Equals Better Support**. The DECD and other State agencies know the aerospace industry and offer manufacturers with targeted support, including assisting in finding the right site to expediting licenses and permits to connecting with public/private research partnerships, and identifying sources for financial and technical assistance. As such, Connecticut has the experience and knowledge to support the exiting aerospace supply chain, as well as to guide the development of the OSW supply chain.

According to Aerospace Components Manufacturers (ACM),[35] this non-profit regional network of independent Connecticut- and southwestern Massachusetts-based aerospace companies' primary mission is to attract the global aerospace industry where member firms form a unique industrial cooperative of long-established aerospace manufacturers, processors, and suppliers, offering a cost-effective supply chain that exceeds customer expectations. Further, as an ACM maps shows, the approximate geographic area covered by the Aerospace Alley which is roughly centered along I-95. It should be noted that the majority of the identified aerospace manufacturing assets are not located along the State's shoreline.

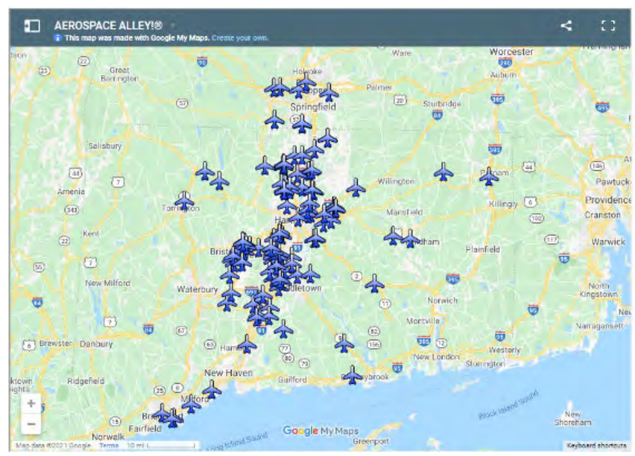


Figure 63 Map illustrating the locations of State aerospace manufacturing firms (Source: ACM)

Over the last several decades, the State aerospace industry has developed and maintained a multi-tiered supply chain to specifically service a wide range of OEMs including GE, GD, Pratt & Whitney, Sikorski, Lockheed Martin, to name a few. There are remarkable similarities between an aircraft jet engine and an OSW turbine. There are tens of thousands of individual parts in an OSW WTG. For existing State aerospace manufacturers, pivoting to producing components for the OSW supply chain will quite feasible and relatively easy.

(sources: https://www.intechopen.com/chapters/38933 and Shutterstock)

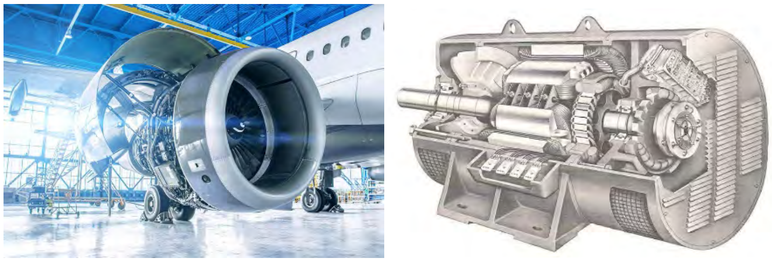


Figure 64 Comparison of an airplane jet engine and an OSW turbine

Maritime Manufacturers

According to the Naval & Maritime Consortium (NMC)[36], there is a large and robust supply chain associated with the GD EB facility. The naval undersea economy is growing, and this growth provides opportunities for economic development across Connecticut and the region. With the planned production of 20 Virginia-class boats (including associated Virginia Payload Modules) and 12 new Columbia-class of ballistic missile submarines, there is a once-in-a-generation opportunity for companies doing business with the Navy and in the submarine supply chain.

For Connecticut, the supply chain for the naval undersea economy is very robust with manufacturer's located in the State and across the region. In a February 2021 report provided by NMC, there are reportedly 392 manufacturing businesses associated with the EB supply chain with well over $1 billion in purchase order awards over the last five years. The manufactured products produced by the supply chain included the following:

- Air Revitalization Equipment
- Electronic Control Equipment
- Control Valves
- Software Development
- Electrical Distribution Equipment
- Specialty Alloys
- Specialty Filters
- Specialized Command & Control Electronic
- Oxygen Generators
- Differential Pressure Transducers
- Specialty Castings & Forgings
- Microswitches
- Specialty Hydraulic Valves
- Shipboard Fire Control Equipment
- High Speed Bearings
- Pipe Fittings

While this report focused on Connecticut, it also included the following citation: "*While the maps offer a good representation of the economic impact submarine programs have on communities, **it is estimated that thousands of additional lower tier suppliers exist across the U.S.*** (emphasis added by MME) *that are not represented*." In the vein that "*a rising tide lifts all boats*," what is good for Connecticut is good for the region and the Country as a whole.

[36] - https://www.nmconsortium.com/the-consortium

The presence of the robust and large EB naval undersea economy supply chain is germane to the OSW supply chain for the following reasons:

- Many of the manufacturing capabilities and worker skills for constructing submarines are directly relevant to the manufacturing of all levels of OSW components. As such, much of the required OSW supply chain entities are already organic to Connecticut and are fully capable of support the first-mover OSW projects.
- As it develops, the OSW supply chain will likely resemble the EB supply chain with various tiers of components being manufactured and supplied by lower-tier-component manufactures to higher-tier-manufactures and eventually to the OEMs for use in constructi

source: Reddit.com

Figure 65 A section of submarine hull being transport by barge

  - These State organic manufacturing assets have developed an effective logistical system to allow for the effective utilization of all levels of manufacturers;
  - Due to the Navy being the end user of the products, the manufacturing entities are all subject to strict QA/QC and record-keeping protocols, as such, it will be relatively simple for firms to understand and comport with European manufacturing standards.
  - The EB supply chain is used to addressing changing design and component requirements, with new classes of submarines brought on-line and existing designs constantly being upgraded and refined. Responding to the newly evolving requirements of the OSW supply chain will be relatively simple for the existing State manufacturers.
  - The EB supply chain currently utilizes the State multi-modal transportation system for the delivery of raw materials by road and rail, to the shipping of smaller sub-components to assembly points to the shipment of large hull sections completed in Quonset, RI and barged to the EB facility. State manufacturers are fully effective and capable of utilizing multi-modal transportation systems.

5.1.3. Advanced Technology

Connecticut is one of the country's and world's advanced technology centers ranging from design services, to manufacturing, to logistics, to O&M, to employee training. This unique and deep State strength will be important to the OSW marketplace for the following reasons:

- The OSW business is a bottom-line industry, and developers and OEMs are extremely cost conscious. This is primarily due to due state-led procurement protocols which formally or informally require a developer to balance out the lowest-possible LCOE with the most local content/net economic benefits.
- The OSW industry is not stagnant and is constantly evolving. For instance, the power-output ratings of WTGs haves been increasing over the last few years to currently proposed 15 MW units (the lower the number of actual WTGs results in lower LCOEs). It is estimated that the maximum

power-output limits for the classic three-bladed WTG geometry is 20 MW, and new types of WTGs, yet to be designed, will be required.

- While the use fixed-bottom foundation types are currently de rigueur for the OSW industry, as the market expands into deeper waters and coastlines of less amenable geology, use of floating-type OSW WTGs will become common. Further, use of concrete GSB foundation types may become more common place to minimize acoustical impacts to marine life during the installation on future WTGs.
- The transmission of offshore wind-generated energy is also evolving from individual project-based grid interconnection to planned transmission strategies through which multiple wind farms can connect.
- The OSW industry is going to require a new type of maritime logistical model in which land-based manufactured products are delivered to Tier 1 manufacturing facilities and/or construction base/marshaling ports for eventual installation at wind farms located well over 20 miles offshore in waters that are hundreds of feet deep.
- The on-going O&M activities of the wind farms will require innovations to maximize up-time while minimizing crew, technicians, and vessel times.
- The future distribution and use of energy will require close scrutiny and monitoring. Will the energy be distributed directly into the grid, stored in yet-to-be-designed batteries, utilized to produce hydrogen (Power to X), or a combination of all three modalities based upon the minute-to-minute monitoring of the electrical grids to allow their management?

Connecticut agile-thinking and experienced manufacturing assets have been successfully addressing challenges with both high- and low-technology solutions for decades in the maritime and aerospace fields, including:

- Keeping up with the development of submarine technologies from the fleet boats of WW II to the newest in vessels in the form of the Columbia-class boat. The Virginia- and Columbia-class vessels represent quantum leaps in submarine technologies including vessel designs, low-acoustical characteristics, crew integration, sensor technology and weapon suites.
- Keeping up with military aerospace technologies, including stealth technology, avionics, vectored thrust, inter-plane/ground sensor communications/integration and rapid ground turn-around times.
- Keeping up with civilian aerospace technologies including the use of composites, low noise producing engines, more fuel-efficient engines, and passenger safety/comfort.
- Keeping up with more low-tech manufacturing processes which include more and more computer controls, use a laser-cutting technologies, environmentally friendly manufacturing techniques and operator safety.

Additionally, all the State’s industrial sectors have their own, large, and complicated supply chains which require the use of robust logistical systems.

To remain competitive, and to produce good and safe working environments, a large portion of the State’s manufacturing assets have embraced the use of advanced technologies to remain relevant in the more-and-more competitive fields in which they operate. The decades of use of advanced technologies by State manufactures will assist OEMs and developers in lowering their respective costs and LCOEs which will allow State assets to develop and further strengthen their position in the OSSW supply chain. State manufacturers have also developed their own supply chains and logistical models, as such, they will be key players in developing and maintaining the OSW supply chain and incredibly complex logistics which will be required to keep the industry running effectively and cost effectively.

5.1.4. Opportunities to Attract New Industries

The OSW marketplace is a new industry in the U.S. which will require the best our nation has to offer to support the successful installation and on-going maintenance. This expansion of a new, renewable source of green energy from hydrocarbon- and nuclear-fueled energy production represents a one-in-a-generation opportunity to re-power the U.S.'s aging, electrical distribution network to combat climate change and global sea-level rise via decarbonization.

Importantly, the OSW industry and its associated supply chain does not require the development of new industries, as the development of nuclear fusion power may, rather it will depend more on:

- Evolving technologies which will allow the use and operations of higher and higher capacity WTGs which will require the other elements of the system to be upgraded (e.g., higher-capacity export cables);
- Development of high-capacity batteries to allow for the storage of OSW-derived energy; and,
- Use of OSW to produce hydrogen (Power to X) as another alternative clean energy fuel.

In a study performed by TetraTech, it was clearly illustrated that due to the scale of the OSW components, and their locations in deep ocean waters off the U.S. coast lines, there will be little opportunities to integrate OSW with the existing and on-going onshore wind market, including their respective supply chains. Therefore, the OSW industry will depend more on the evolution of larger scale, integrated OSW components including the WTGs, associated cables, and substations, and how the derived energy will ultimately be utilized by the end customers. Connecticut is well positioned to fully support this evolution of a new energy production system, including with its ports infrastructure and manufacturing assets which will be able to effectively guide the development of the associated supply chain.

5.1.5. Major Components Manufacturing

As discussed above, the manufacturing of major OSW components such as blades, towers, foundations, cables, etc., typically require large and robust port facilities without air-gap restrictions. It should be noted, these are the "*sexy*" part of the OSW industry, and all the East Coast states are actively vying to attract such Tier 1 manufacturing facilities. However, it is widely believed in the industry that only one or two manufacturing facilities for each Tier 1 component will be required for the East Coast, and it is anticipated that inter-state competition will be fierce to attract and land such a manufacturing facility. Further, even when procurement contracts are awarded for the products of these Tier 1 manufacturing plants, it will require several years to design, permit, and construct such a facility. As such, there will be a long lead time between award and actual revenue generation for a Tier 1 manufacturing facility. As such, MME believes that the future manufacturing of Tier 1 components should not be a priority for Connecticut, although the State should allow and encourage such development as part of its normal business practices.

5.1.6. Tier 2 through Tier 4 Supply Chain Components

Connecticut's greatest strength and opportunity to enter the early OSW supply chain is to leverage its existing and diverse manufacturing assets which are located across the State. This high-state of readiness will make it more feasible for supply-chain entities to meet their both formal and informal local supply requirements, as well as de-risking potential supply-chain disruptions associated with trans-shipping components from overseas. Once State manufacturers become relevant and well known in the offshore wind supply chain, additional procurement opportunities will follow, and the manufactures will have ample time to plan and build out their manufacturing infrastructure to keep up with the demand as the OSW market matures over time.

Once Connecticut manufacturers have staked their claims and have successfully proven to the OSW supply chain that they are fully capable of serving the marketplace, we believe that the State will become known as a U.S. go to hub with a strong anchor position in the manufacturing of lower-tier OSW components. As the OSW market starts to pick up speed and matures over the next few years, more and more suppliers will look to open new manufacturing facilities in the U.S., and due to its early entrée into the market, Connecticut will be able to effectively attract opportunities to open new facilities to meet the demands of the OSW supply chain. Another advantage that the State will have with its early entrée is the early development on an effective multi-modal logistical system which will be able to support all levels of the supply chain, thereby driving down costs and increasing the reliability of the overall supply chain.

5.1.7. Service Level Supply Chain

The O&M of the OSW farms represents a 20+ year opportunity to Connecticut residents to have long-term, good-paying jobs in the OSW business. As discussed in detail below, O&M services fall into two general categories, including the following based upon the steaming distances involved and types of specialized vessels available:

- Crew Transfer Vessels that support daily crew operations with maximum 1.5-to-2.0 hours of one-way transit time. A CTV port facility typically provides a primary headquarters for day-to-day O&M activities, remote-monitoring/operation-center services, major maintenances, daily transportation of technicians and supplies to the offshore windfarm, and unplanned deployment of personnel or equipment for emergencies or failures. Typical average vessel speeds of CTVs are 15-25 knots, leading to a recommended transit distance of less than 50 nm one way from an associated wind far, which results in nominal-conditions travel time under two hours for the vessels and crew.
- Service Operation Vessels conduct long-term, multi-day/week operations and only periodically return to their base port. SOVs are larger vessels that are utilized to support a greater variety of OSW operations including geotechnical and seismic surveys, tug and supply operations, construction support and providing maintenance support. SOVs typically provide routine maintenance for windfarms that are located to far offshore to be effectively supported by CTVs. O&M operations that can effectively be conducted by crews working multi-week shifts and are more effectively conducted by hotel-style SOV vessels.

  The typical operational model for SOVs is that they will return to port every two-to-three weeks for a change of crew personnel and resupply. Ideally this can be completed with a transit overnight (10-20 knots in 12-14 hours), crew change during the day, and transit back to the field the next night, so that only one crew working day is lost.

Due to its location close to the Massachusetts OSW farms and the overall size of the property, the Fisherman's Landing property in New London would be well suited to support CTV-type O&M operations for multiple wind farm operators. It could also accommodate SOV operations. Due to the longer steaming distances, the Bridgeport properties are not as amenable to support CTV operations; however, they would be well suited as home bases for SOVs.

Connecticut is well suited to support and attract service-level operations for the OSW farms as they come online. The larger SOV ports will be required to have secure indoor storage for a small number of larger components such as blades, while both CTV and SOV facilities will need secure indoor storage for smaller sub-components such as bearings, lubricants, electrical control boards, etc. The supply chain that will develop as part of the installation of the wind farms will be sufficient and effective in supporting the on-going service-level operations.

5.1.8. Existing Maritime Support Operations

Connecticut has an existing, strong, and robust maritime industry that is made up of various vessel types and facilities that have been supporting State maritime operations for decades. For instance, Mohawk NE has been providing fabrication, barge and maritime construction services from their locations located on the east and west banks of the Thames River.

Another excellent example of a firm that has been providing maritime operations in State waters is Cross Sound Ferry (CSF) and related companies, which started business in the 1800's with the current family operations beginning in the 1960's through today. Their New London-based operations include the following:

Figure 66 - Cross Sound Ferry heading up the Thames River

- Providing year-round passenger and/or vehicle ferry between New London, Orient Point (in Long Island) and Block Island (in Rhode Island).
- Ferry support services to provide commodities and goods to Fisher, Block and Plum islands.
- Dry dock, vessel maintenance/repair services at their Thames Shipyard facility located approximately one mile north of the Gold Star Memorial Bridge on the west bank of the Thames River. The facility is equipped with two dry dock facilities including a large dry dock that can handle 8,000 ton, 350-foot-long vessels and a second smaller dry dock that can accommodate smaller vessels. These dry docks commonly serve five-year inspections required by the U.S. Coast Guard, as well as generalized vessel maintenance

and repair activities. The presence of this shipyard will be critical in supporting CTV and SOV operations as it is currently in-service, and it would be very difficult to bring a "*new*" similar facility into use.

- Thames Towboat operates a tug fleet which provides services across the New London region including the Groton Submarine Base, Electric Boat, the State Pier, the Dow facility, etc. Their tugs are typically harbor and river tugs which provide vessel-assist operations at the various quay side facilities. While Thames Towboat would not support offshore tug-operations associated with the use of feeder barges, they would provide tug-assist operations when the feeder barges are brought to and leave a quayside. Thames Towboat has expanded their fleet by recently adding one tug with plans on expanding their tug fleet by two additional vessels specifically to support the offshore wind industry.

Figure 67 - Aerial Image of Cross Sound Ferry Dry Dock Operation

CSF and related companies are another example of an existing State asset that is presently fully capable of supporting short-term OSW operations and can support the first mover projects which will stage out of Connecticut, especially in the New London harbor area.

5.2. Current Business Climate

As part of preparing this document, as well as part of our overall working in the OSW marketplace, MME personnel met with representatives from multiple developers, OEMs, service providers, port operators, vessel operators and manufacturing entities. Based upon these discussions, MME provides the following summary of perspectives on the current business climate in Connecticut:

- There is a general feeling of "offshore wind fatigue" due to all the hype around OSW that resulted little actual spending or procurement opportunities to date.
- Many State entities believe that the OSW industry will primarily result in jobs at port facilities located along the coastline.
- There is a general feeling of excitement regarding OSW finally starting up.
- Most business entities are concerned that significant financial investments will be required by them before they can start making money in the industry. This is especially the case with port facilities. Another concern for ports revolves around the high costs of development of the specialized port infrastructure and whether the installation phase of OSW will last long enough for the owners to recoup their costs and make a reasonable profit.
- There is a general concern regarding how existing State manufacturing entities can successfully enter the offshore wind market, including the timing and scale of procurement requests. The manufacturers are also concerned that they do not fully understand the needs of the currently European-based OSW industry.

- A concern across multiple portions of the industry is the shortage of skilled and experienced workers required to meet future anticipated OSW-related contracts. There was not a single class of worker, rather nearly all the businesses we communicated with expressed deep concerns of this issue including machinist, welders, stevedores, vessel officers and crew, engineers, painters, procurement specialists, to name a few. Participants in the existing EB supply chain were very vocal about this issue.
- To date, the OSW market is relatively inward facing and expects supply chain entities to come to them. This is seen in multiple state's supply chain data bases, developer-approved databases of service providers and that industry representatives are basically required to participate in OSW-specific conferences.

5.3. Training and Investment

The following provides a discussion regarding training and investment opportunities to aid Connecticut workers access to good, high-paying jobs in the OSW industry.

Training

Currently, the U.S. OSW industry is focusing on the training requirements to operate in the offshore environments, including those associated with vessel and helicopter operations. There will be a focus of the health and safety of offshore workers including working a heights, in water and around highly-dynamic operating machinery – all from either vessels or helicopters. GWO safety standards are in the industry standard for this type of work and there are currently several programs in existence or in development that can provide this GWO certified training.

There is also a need for engineers, scientists, and planners to support the development of the OSW industry; in recognition of the anticipated opportunities for students pursing advanced degrees, several universities in the Northeast have launched OSW-specific programs.

Finally, there will be an incredible need for skilled and experienced workers across all sectors of the OSW industry including welders, painters, machinists, fitters, crane/vessel operators, etc. It should be noted that these required skills are not just specific to the OSW market. They are typically taught via apprentice programs and vocational institutions. The challenge facing the State's manufacturing entities is that these educational/learning programs often take years to complete before a worker is sufficiently competent to provide the required services.

Investment

In order to capture a share of the OSW market that is currently developing in U.S. East Coast, Connecticut will need to make significant investments in a wide range of areas, including the following:

- ***Upfront Investments***: European developers and OEMs are used to working in a mature industry where port assets, manufacturing facilities, trained workers, etc., are all currently available. They are not used to paying upfront to develop assets, and not necessarily receptive to later payment methods such as tax incentives or payment in lieu of taxes (PILOT) programs.
- ***Job Training Programs***: The State should sponsor the development of vocational training and apprenticeship programs. These programs will prove critical in allowing Connecticut to retain one of its main assets: young people who want to live and work where they grew up but cannot find good, high-paying jobs to allow them to stay for their careers and raise their families.
- ***Develop an Outward Facing OSW Program***: The State should develop programs to reach out to non-OSW manufacturing companies to educate them regarding the skills, training and

certifications required to enter the OSW marketplace. Further, State personnel knowledgeable about the OSW marketplace should attend and participate in other industries trade shows and conferences to educate participant regarding the opportunities in this developing field.

- **Support Large Scale Project**s: In a case of "*where money talks*," the State should develop and implement programs which provide preliminary funding for large-scale projects. Such programs could include Private-Public Partnerships (PPPs) with State and other interested entities for pursuing US DOT grants such as INFRA, RAISE and PIDP.

6. Workforce Development

The State of Connecticut has a highly skilled and diverse workforce, from high-technology services associated with the aerospace industry including specialized manufacturing capabilities, to its rich history of working in the maritime environment, most notably with the submarine base and EB facility located in Groton, as well as its talented engineering workforce, with several nationally recognized universities. These diverse skill sets position the State to be well-suited to meet the varied needs of the OSW industry, from the planning and design phase, through to construction and implementation, and throughout its life cycle into the O&M phase.

Large-scale OSW projects generate a diverse set of sustainable jobs and provide socio-economic benefits. A joint report from the Global Wind Organization (GWO) /Global Wind Energy Council (GWEC) projects that nationwide, from 2021-2025 there will be 9,100 construction jobs and 25,300 people in the US needing training[37]. However, as the industry develops, the number of available jobs will grow as well. Massachusetts projects between 2,300 and 3,100 construction jobs years, and between 140 and 256 annual jobs associated with O&M[38], all of this based on 1.6 GW of offshore wind-derived energy. Nationally, the DOE projects between 170,000 and 181,000 jobs created by OSW by 2050.

There are three main job types that will result for the development of the offshore wind industry:

1. *Direct jobs* are those created to directly support the OSW marketplace, such as service technicians, vessel crews, etc.
2. *Indirect jobs* are those created as a result of the OSW marketplace spending on goods and services including manufacturing; and,
3. *Induced jobs* are created by the spending of the OSW employees within the region such as restaurants, grocery stores, etc.

These job projections are direct employment from the OSW farms themselves and do not include the indirect and induced job benefits. Onshore Wind, for instance, supported 17,400 manufacturing jobs in 43 states in 2013[39].

A 2009 study performed by FXM Associates[40] for a development project in New Bedford (which was constructed in 2015) indicated that the 30-acre purpose-built port project was estimated to expand business output in the City by more than $44 million, provide nearly 400 person years of employment, and $19.2million of additional household income in the County over its estimated two-year construction period. Statewide effects of this construction were estimated to include an expansion of business output by nearly $66 million, person years of employment by over 500, and household income by more than $26 million. These economic impacts include the total direct, indirect, and induced effects across all industries in the state. Similarly, the proposed improvements that are on-going at the State Pier in New London will create an estimated 460 direct jobs and 395 indirect &

[37] Global Wind Workforce Outlook 2021-2025, June 2021 – Global Wind Organization and Global Wind Energy Council

[38] Massachusetts Clean Energy Center, 2018 Massachusetts Offshore Wind Workforce Assessment

[39] Wind Vision; A new era for Wind Power in the United States – US Department of the Energy

[40] "Economic Effects of Offshore Wind Energy and Related Construction and Operating Expenditures" Prepared by FXM ASSOCIATES, December 2009

induced jobs created during the pier infrastructure improvements, and an anticipated 400+ high-skilled long-term employment to serve the wind turbine generator operations after construction[41].

Connecticut workers must have the proper training and certifications required to participate in this emerging industry and benefit from the associated economic development. Each of the different types of jobs has specific education, skills and HSE credentials/training required to perform those services. The State has existing programs and plans that reach the capacity to provide the technical and HSE training that workers will need.

The emerging OSW sector is poised to create thousands of job opportunities across a wide range of sectors, and we are confident that our proud maritime heritage, robust innovation sector, and skilled workforce will help lead Connecticut towards a brighter clean energy future.

6.1. Existing Workforce Programs within Connecticut

The State has several existing and effective programs that it uses to develop its workforce, not all of which are specific to OSW-specific jobs, but programs that could be effective at developing and expanding the supply chain.

The 2020 Governor's Workforce Council Strategic Plan[42] identified that in the manufacturing sector along, prior to the pandemic, the demand for manufacturing workers exceeded the supply by 3,000 jobs per year. There are several programs and initiatives in place to address this gap in available trained workers.

A model program administered by the Eastern Connecticut Workforce Investment Board is the Manufacturing Pipeline Initiative. This seven to ten-week training program has trained thousands of people and is a model being exported to other parts of the state and the nation. Another exemplary program is the Workforce Development Program Administered by the Aerospace Components Manufacturers Association. This is a 10-month course that teaches subjects from applied shop math through the machine operator process, quality controls and safety and supervisory requirements.

At the Community College level, the nine campuses of the Connecticut State Community Colleges offer a 24-week advanced manufacturing course. As part of those local programs, there is also the Center for Next Generation Manufacturing which is led by the Connecticut College of Technology. This program is a great tool to create partnerships with industry and the educational communities.

6.2. OSW Job Types and Projections

Before we can delve into the education and training requirements, it's important to understand the types of jobs created by and serving OSW projects.

[41] Terminal Development | Gateway New London | New London State Pier (gatewayt.com)

[42] https://portal.ct.gov/-/media/Office-of-the-Governor/News/20201028-Governors-Workforce-Council-Strategic-Plan.pdf

6.2.1. Direct Jobs

Direct Jobs from offshore wind farm development projects fall under the three following main categories: Development Team, Construction Team, and the Operations and Maintenance Team.

The Development Team would include:

- Geophysicists and Marine Surveyors
- Marine Biologists
- Civil, Geotechnical and Electrical Engineers
- Permitting Specialists
- Legal advisors
- Public Relations and Marketing Firms
- Port Facility Operators and Managers

The Construction Team would include:

- Engineers
- Construction Supervisors and Foremen
- Equipment Rental and Maintenance suppliers
- Water Transportation (Tugs, Barges, etc.)
- Trade Workers
    - Longshoremen/Stevedores
    - Iron and Steelworkers and Pile Drivers
    - Millwrights
    - Electricians
    - Machine Operators
    - Plumbers and Pipefitters
    - Laborers
    - Elevator Constructors
    - Commercial Divers
- Health and Safety Professionals

The Operations and Maintenance Team would include:

- Wind Farm Technicians
- OSW Site Managers
- OSW Team Engineers
- Water Transportation

To create projections of the workforce requirements and jobs created, we modeled several scenarios using NREL's Jobs and Economic Development Impacts (JEDI)[43] model. These models simulated various inputs and assumptions for the deployment of several projects including those of a similar scale to the Park City Wind project, the Revolution Wind Project, and a future project to develop the remaining 800 MW that the State has committed to under executed energy solicitations. While these projects were modeled to mimic the scale and impact of the two projects being deployed from the State, they

[43] Jobs and Economic Development Impact (JEDI) Models | NREL

should not be considered exact models of each project as the JEDI system is set up with some standardized assumptions and cost factors that do not consider specifics associated with each project. Based on the input provided, the JEDI model outputs information regarding the number of full-time equivalents (FTEs) jobs created, earnings associated with those jobs, economic output, and value added to the economy from direct employment, the supply chain (indirect jobs), and the induced benefits. The models were run based on three different local content percentages, a higher end projection, the default projection, and a lower end projection.

The scenario modeled was an 800 MW project deployed out of Bridgeport using 12 MW WTGs. The results of the JEDI modeling suggested between 250 and 480 direct jobs or FTEs associated with the installation activities of the project, between 5,150 and 5,180 supply chain FTEs, and between 1,880 and 1,890 induced FTEs. In terms of economic impact, the project would create between $669 million and $690 million in earnings, between $1,639 million and $1,677 million in output, and between $877 million and $916 million in value added.

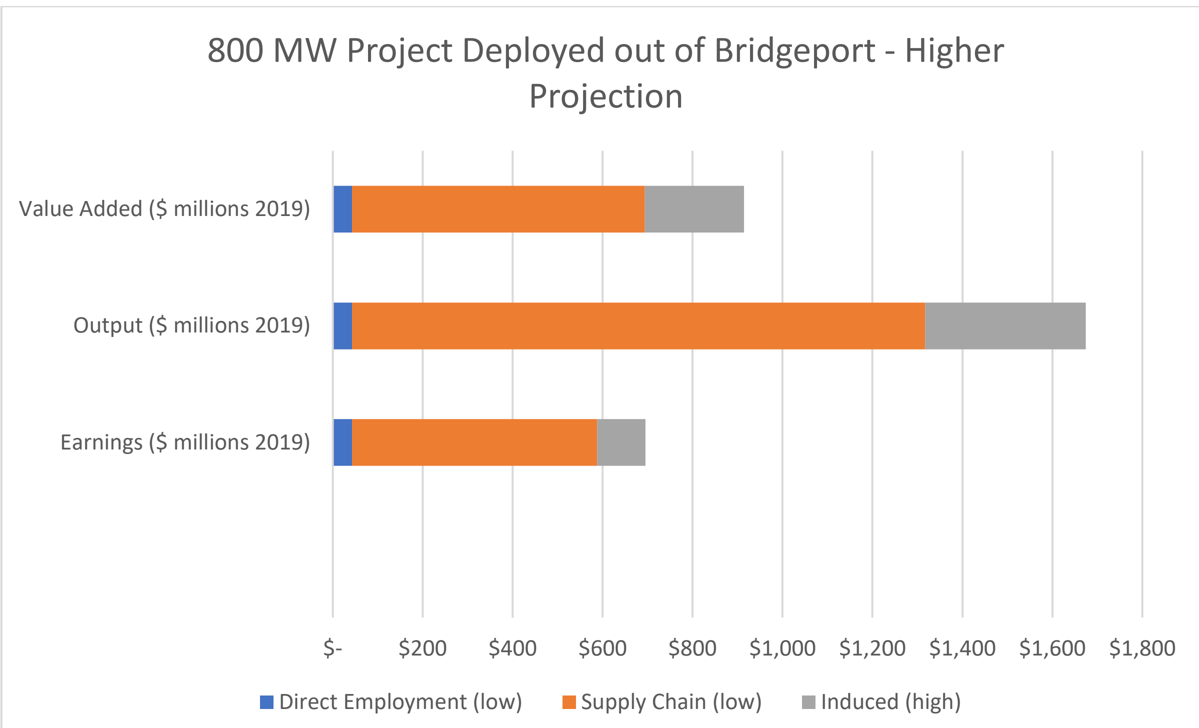


Figure 68 Economic Impact 800 MW Project Deployed out of Bridgeport

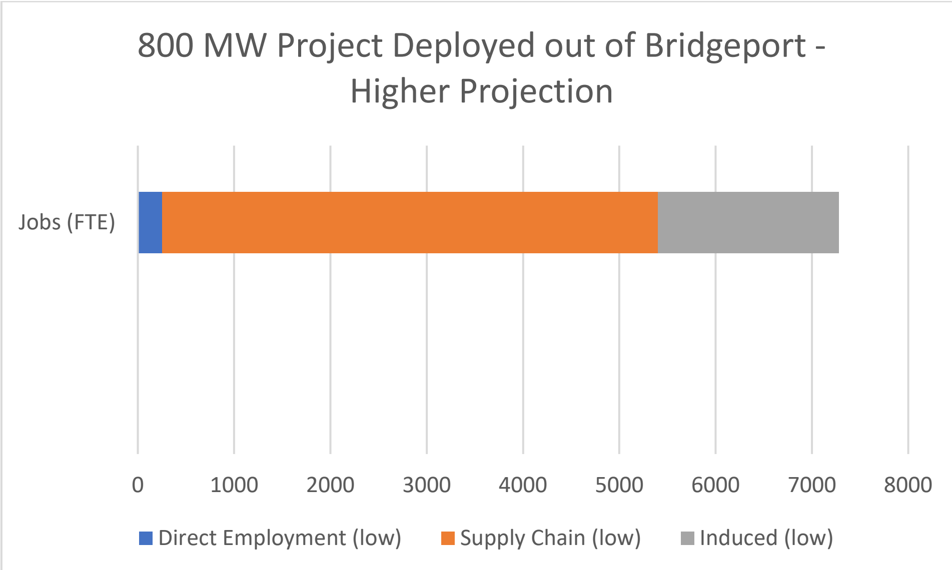


Figure 69 Jobs Projection 800 MW Project Deployed out of Bridgeport

The second scenario modeled was a 400 MW project deployed out of New London using 12 MW WTGs. The results of the JEDI modeling suggested between 131 and 247 direct jobs or FTEs associated with the installation activities of the project, between 3,047 and 3,067 supply chain FTEs, and between 1,118 and 1,126 induced FTEs. In terms of economic impact, the project would create between $399 million and $411 million in earnings, between $964 million and $983 million in output, and between $532 million and $564 million in value added.

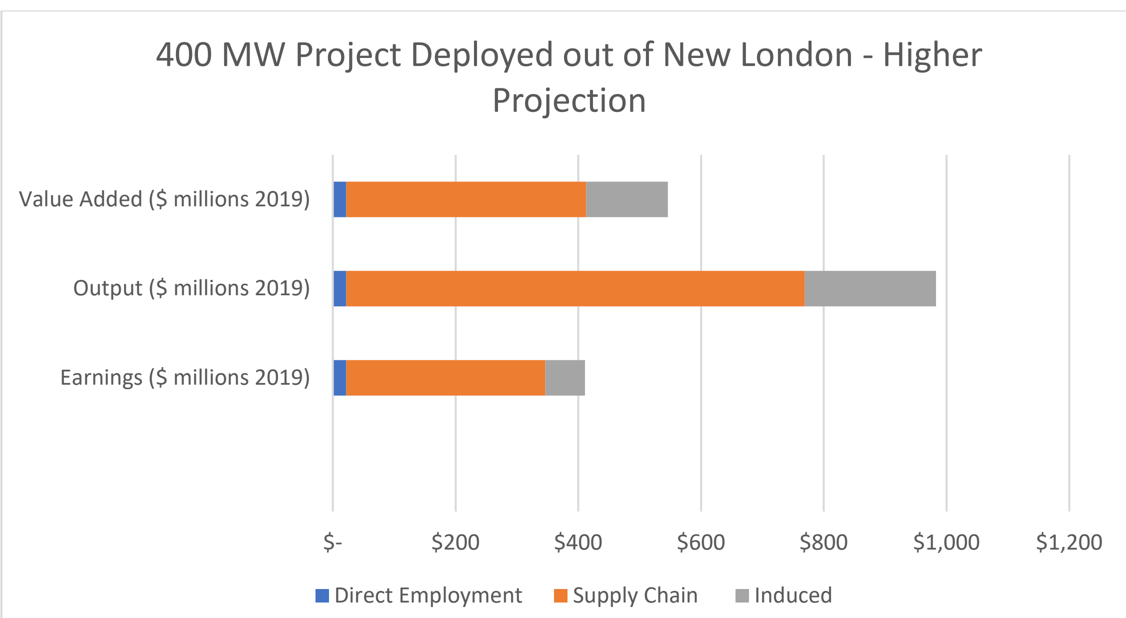


Figure 70 Economic Impact 400 MW Project Deployed out of New London

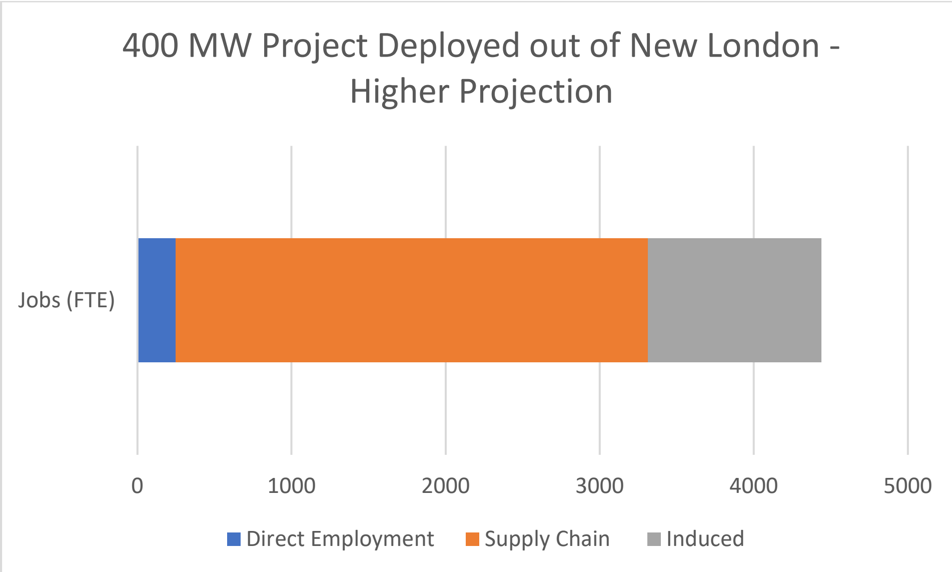


Figure 71 Jobs Projections 400 MW Project Deployed out of New London

The third and final scenario modeled was an 800 MW project deployed out of New London using 15 MW WTGs. The results of the JEDI modeling suggested between 224 and 424 direct jobs or FTEs associated with the installation activities of the project, between 5,007 and 5,041 supply chain FTEs, and between 1,838 and 1,853 induced FTEs. In terms of economic impact, the project would create between $660 million and $682 million in earnings, between $1,607 million and $1,642 million in output, and between $871 million and $897 million in value added.

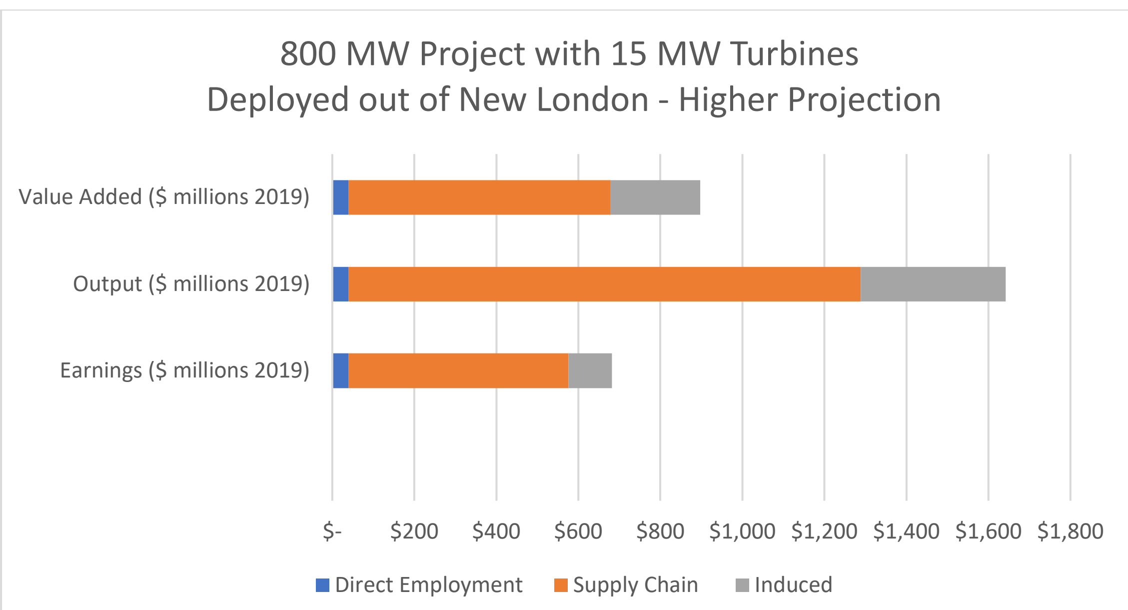


Figure 72 Economic Impact 800 MW Project with 15 MW Turbines Deployed out of New London

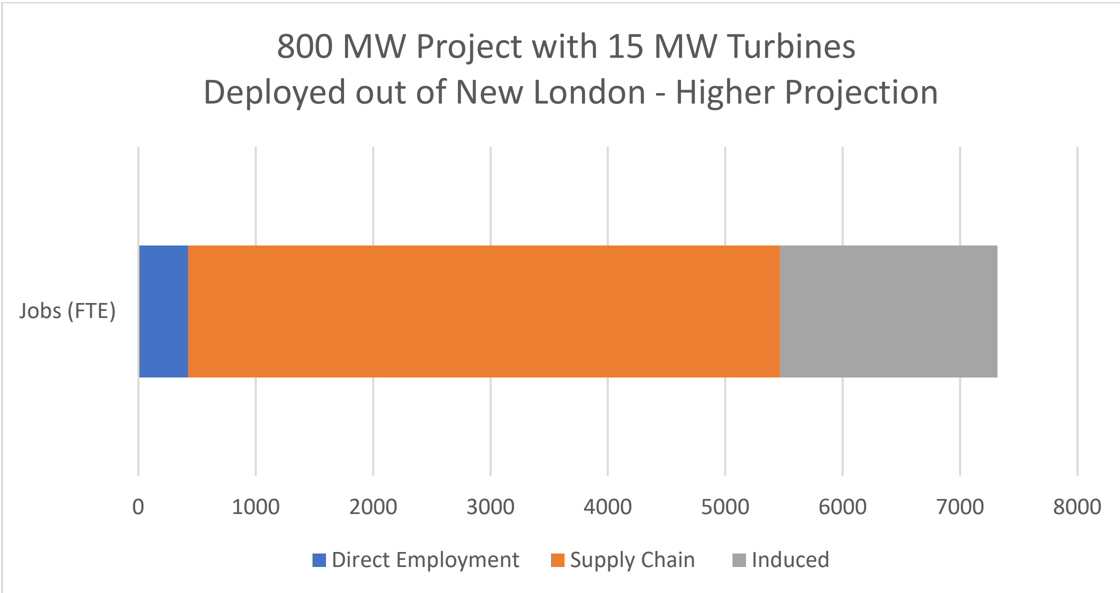


Figure 73 Jobs Projection 800 MW Project with 15 MW Turbines Deployed out of New London

A study conducted in the UK in 2018 suggested that the demand for labor related to offshore wind would be greatest for technical/professional staff and Managers[44]. That model, based on data from Cambridge Econometrics 2017 employment projections, shows a breakdown of workforce projections as shown in the chart below:

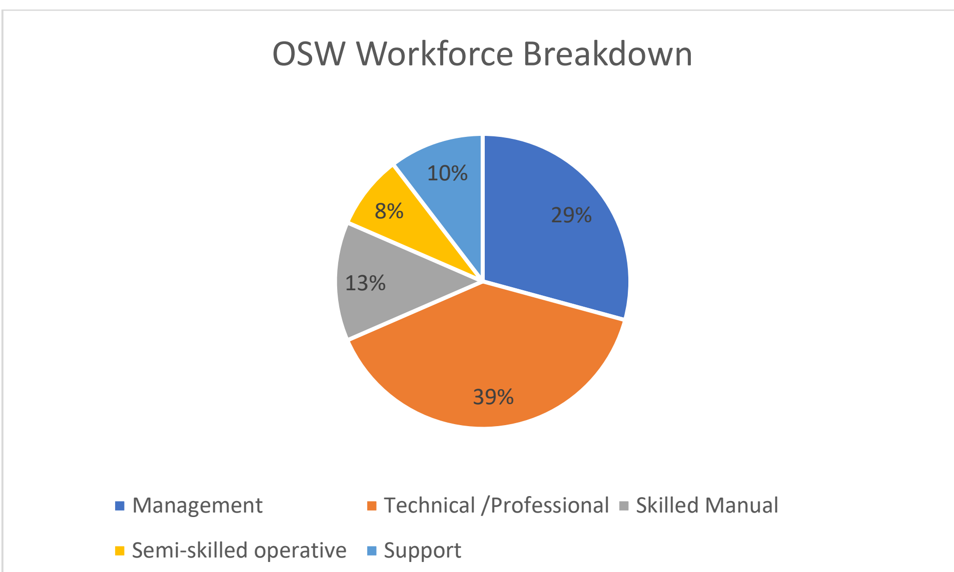


Figure 74 – Projections of OSW Workforce Breakdown by Category

[44] Skills and Labour Requirements of the UK Offshore Wind Industry 2018 to 2032, © 2018 Energy & Utility Skills Limited

What this model is showing that OSW can provide significant economic benefit, with a breakdown of FTE/MW in the range of

- Direct Employment – 0.3- 0.5 FTEs/ MW
- Indirect Employment – 6.6-6.64 FTEs/MW
- Induced Employment – 2.41- 2.44 FTEs/MW
- Total Employment Impact – 9.3-9.7 FTEs/MW

6.2.2. Training and workforce requirements and curricula

As noted in the previous section, there are a wide variety of skillsets and workforce categories that would be involved in the OSW industry, all with a wide variety of training requirements. For the purposes of this study, the following specific offshore wind labor skillsets we evaluated:

- Wind Engineering
- OSW Technicians
- Advanced Manufacturing
- Advanced Skills Trades

6.2.2.1. Wind Engineering

Wind energy engineering professionals received a broad variety of engineering training, from planning, electrical, mechanical, geotechnical, geophysical, and civil engineering disciplines. There are also several different degree levels that could be earned, from a professional certificate through to a PhD program. There are several existing programs that offer an example of the target students and sample curricula.

The University of Massachusetts Amherst offers a professional certificate program offered to "*to professionals and graduate students seeking to up-skill and broaden their knowledge to address the needs of the OSW industry. This certificate covers the broad range of disciplines involved in this industry, including technology and engineering, development and finance, supply chain management, marketing, environmental impact, business logistics, law, and policy*.[45]" This curriculum is aimed at providing an understanding of OSW technology, electrical grid considerations, environmental and design considerations and issues, as well project deployment and logistical issues. This is a one-year online program.

For more advanced, specialized training, Tufts University offers a wind energy engineering program for post-baccalaureate certificates, master's degrees, and doctorate programs[46]. These study programs curriculum provide an interdisciplinary training module with a focus on structural and geotechnical engineering for the turbines, electrical/ clean energy training, data science, controls and power systems training, and policy, economics, and management training. These training programs are interdepartmental, with courses offered through several different departments including Civil engineering, mechanical engineering, electrical engineering, economics, public policy, and engineering management.

[45] Clean Energy: Offshore Wind Professional Certificate | UMass Center for Agriculture, Food and the Environment
[46] Offshore Wind Energy Engineering | Tufts University - Graduate Programs

6.2.2.2. OSW Technicians

OSW technicians are multi-skilled members of the developer's/operator's team that operate, maintain, and repair the turbines and associated infrastructure. OSW technicians generally work outdoors, in confined spaces, and often at great heights, so along with the required technical skillset(s), they also need thorough HSE training, including working at heights, fall protection, helicopter operations, etc.

The GWO sets the standards for training requirements that are needed for offshore wind technicians[47]. They establish the curriculum and can certify the training providers to ensure consistency across the industry. There are several programs that provide GWO-certified training in the Northeast, including Survival Systems USA in Groton, CT, as well as partnerships such as that created by Crowley Maritime and Relyon Nutec. The GWO training is an industry standard and is a minimum requirement for all OSW technicians. It should be noted that, depending upon the location(s) of the work being conducted, U.S.-based operations will also fall under the jurisdiction of both the U.S. and state Occupational Safety and Health Administration (OSHA) and Bureau of Safety and Environmental Enforcement (BSEE).

Beyond the GWO training, there are other skillsets and trainings that technicians should have to work safely and be competitive in the marketplace. Bristol Community College, as part of the National Offshore Wind Institute[48], provides technical training that includes modules on mechanical, electrical, and hydraulics that will assist technicians in operating and maintaining WTGs and associated systems. These program train technicians to understand the unique challenges around OSW turbines. They get trained on the engineering principles behind wind turbine operation, design strategies so that they are better prepared to troubleshoot issues in the turbine assemblies and components.

6.2.2.3. Advanced Manufacturing

WTGs have several large components and within most of those large-scale components there are several sub-components. A nacelle for example, has several sub-assemblies in it, but overall will have thousands of pieces and parts to create that assembly. While the U.S. is unlikely to compete on some of the basic machining parts for early OSW projects, there are several sub-components that require advance manufacturing technology and skills where local manufacturers can be competitive for the global supply chain.

The nacelle sits at the top of the tower sections and the blades are connected to nacelle. The nacelle is the part of the turbine that houses the components that transform the wind's kinetic energy into mechanical energy to turn a generator that produces electricity., nacelles are rather they are assembled - not manufactured as a complete system - with components that work together to harness the power of the wind and turn it into reliable, clean energy.

These nacelles are incredibly complex, specially engineered components, with most having subcomponents such as a hub, rotor, a drivetrain (gearbox and generator or direct drive generator), inverters, hydraulics, cooling systems, pitch and yaw systems, and bearings. Most offshore nacelles are now equipped with helicopter landing pads for safer and quicker access, and service.

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[47] GWO Training Standards (globalwindsafety.org)
[48] http://www.nowi.org/

Smaller, mostly onshore turbines have historically used a gearbox and generator to transmit the low-speed revolutions of the blade to a speeds high enough to create reliable energy. The larger offshore turbines now use direct drive generators, which rely on magnets convert the blades speeds into energy. The gearbox systems are equipped with many moving parts and therefore, were often the root of maintenance, and while the direct drive generators are significantly heavier, they have fewer moving parts and are more reliable. The U.S. DOE is funding projects to advance technology in creating powerful more lightweight direct drive generators[49].

The yaw systems control the head of the nacelle, make it possible for them to turn or pivot into the direction of the winds, to optimize the efficiency of the production of energy. Similarly, the pitch systems control the angle of the blades to ensure that the blade exposure to the wind is optimized.

Each OEM sets its standards for specifications on materials, tolerances, and quality, and only they can dictate what specifically is needed, however there are several of the systems that present opportunities for manufacturers in Connecticut.

Based on our conversation with selected OEMs and sub-component manufacturers, there are no OSW-specific manufacturing training requirements, but the standard advance manufacturing training programs would apply. These programs, such as those administered by Connecticut Center for Advanced Technology, Inc (CCAT)[50], the Manufacturing Alliance Service Corporation (MASC)[51] and several of the programs sponsored the Advance Manufacturing CT[52] provide the skillsets needed to provide advanced manufacturing services. These skills include mathematics, blueprint reading, job planning, machine operations, milling and other manufacturing skills and the programs are often set up with apprenticeship opportunities to gain hands-on experience.

6.2.2.4. Advanced Skills Trades

The skilled trades, such as pile drivers, iron workers, electricians, and welders will play a significant role in the deployment and development of the OSW industry. Typically, workers are trained at technical/vocational schools or at community colleges, and then participate in apprenticeship programs to gain on the job experience. These jobs provide solid pay and are very often in demand.

Welders are skilled trade group that is currently and projected to remain very much in demand. According to the US Bureau of Labor statistics[53], "*Employment of welders, cutters, solderers, and brazers is projected to grow 3 percent from 2019 to 2029... The nation's aging infrastructure will require the expertise of welders, cutters, solderers, and brazers to help rebuild bridges, highways, and buildings.*"

[49] Advanced Wind Turbine Drivetrain Trends and Opportunities | Department of Energy

[50] https://www.ccat.us/education-workforce/manufacturing-career-advancement/manufacturing-careers-program/

[51] https://www.mascttc.com/manufacturing-skills

[52] https://www.advancingmanufacturingct.com/

[53] Welders, Cutters, Solderers, and Brazers : Occupational Outlook Handbook: : U.S. Bureau of Labor Statistics (bls.gov)

According to the American Welding Society, the industry will encounter a shortage of about 300,000 welders by 2024. Several people in the industry that MME spoke with have mentioned that it is very difficult to attract and keep quality welders.

The NAM has reported that 60 percent of the manufacturers looking to hire are rejecting about half of all applicants because they lack welding skills and training. NAM also says that over 80 percent of U.S. manufacturers complain that they cannot find enough skilled welders to meet the demand, which is why effective welding training programs and apprenticeship programs are critical.

Welders have a skillset that can translate across several industries, particularly within Connecticut, including OSW, maritime, shipbuilding, and civil infrastructure (bridges). There is a subset of welders, underwater welders, who are typically commercial divers. This skillset is going to be increasingly in demand as divers will need to inspect and maintain turbined components below the waterline, in the foundations and connections to the superstructure of the WTG.

6.3. Opportunities to develop new training programs

6.3.1. Construction Services

As mentioned earlier, Eversource is partnering with the Eastern Connecticut Workforce Investment Board (EWIB) to develop an OSW specific training program that will incorporate the safety aspects of working on these large projects, as well as the technical training for compiling, picking, loading, hauling, and installing these components. Other programs, such as *Helmets to Hard Harts* and apprenticeships programs through the Connecticut State Buildings and Trade Council members are great opportunities to train more skilled and qualified workers and develop of steady pipeline of construction-service workers that will be needed to support the buildout of the U.S., offshore wind industry.

6.3.2. Engineering and professional services

Connecticut is flush with engineering programs and engineering development programs starting in high school and available in the community colleges, as well as its four-year universities and graduate programs. Because OSW programs require a multi-disciplinary team of geophysicists, structural engineers, geotechnical engineers, mechanical engineers, and electrical engineers, among others, the State should continue to support the development of engineering talent.

Starting at an early age, science, technology, engineering and mathematic (STEM)- focused high schools, such as the Academy of Aerospace and Engineering in Windsor, are educational institutions where students can receive high-level training from professional engineers through mentorships and advanced placement into college programs and can even successfully receive summer internships or placements with companies for real-world work experience while still in school.

At the community college level, Connecticut has several high-quality institutions that cover a broad geographic region that already have strong engineering programs, from- Quinebaug, Three Rivers, Gateway, Naugatuck Valley, Manchester, Norwalk, and Asnuntuck Community Colleges.
Similarly on the four-year level, UConn, Yale, University of New Haven, University of Hartford, Central Connecticut State, Fairfield, and Goodwin all have good-strong engineering programs.

These institutions already have the infrastructure and curriculum for engineering programs developed and, with some encouragement and education about the requirements and benefits, could easily expand to develop OSW engineering programs to develop the talent pipeline for the State.

6.3.3. Operations and Maintenance

Park City Wind, as part of its commitment to the State, is actively working to develop program and training opportunities, with a focus around the Bridgeport area. They are developing a partnership with Goodwin University to develop a program focus on O&M activities associated with OSW farms. Park City Wind is also developing partnerships with local high schools and community colleges for their advanced manufacturing training to expand those programs towards offshore wind-related engineering. Housatonic Community College has one such program that offers a certificate for an OSW technician. Their goal is to have a sufficiently trained and qualified workforce pool ready and available in time for when the Park City Wind project is operational as which point O&M operations will commence in earnest

Similarly in the New London/ Eastern Connecticut area, Revolution Wind, through Eversource, is committed to developing a workforce training program with the ECWIB. The full details of that program are still under development.

According to NREL,[54] workforce projections from the O&M phase of the offshore wind market (in the Mid-Atlantic and Southeastern regions) would require approximately 1.2 to 1.6 FTE per MW and during the O&M phase. Further, there are approximately eight jobs in the supply chain for every job in project development. Based on these projections, for the 1,200 MW of OSW-derived energy committed under the two Connecticut projects, there would be 1,440 to 1,920 jobs created with both project development and supply chain aspects. Applying the ratio of eight supply chain jobs to one project development, that would result in an estimated 160 to 213 jobs of project development and an estimated 1,280 and 1,706 supply chain jobs required within the State. Please note that these numbers differ from the JEDI modeling shown before as these numbers are specific to the State, whereas the JEDI model just looked at the economic benefit of the project, and that benefit could occur nationally and internationally.

If both training programs proposed by the Connecticut OSW developers are in place by 2024, there would need be sufficient workforce offshore wind technician training available to service the in-contract projects which would result in jobs for an estimated 106 to 142 annual jobs in the Bridgeport area to support Park City Wind, and 54 to 71 annual jobs in the New London area to support Revolution Wind.

6.3.4. Travelling shipwrights' program

Reportedly, many shipwrights "follow the work" across the U.S. to maintain their employment. An example of this are workers who specialize in refueling nuclear-powered naval vessels, a process that can take several months to complete.

It is believed that there are several shipwright specialties such as welding, nuclear specialties, etc., that could benefit these workers by keeping them employed and allow them to work at locations

[54] Offshore Wind Jobs and Economic Development Impacts in the United States: Four Regional Scenarios (energy.gov)

across the country thereby maintaining a highly trained and specialized work force. One strategy for Connecticut is to supplement its supply chain database with a skilled worker/shipwright database. While the State wouldn't be involved in the direct employment and recruitment of workers, as it develops talent and trains individuals, it would be useful to enter their information into a database that would allow them to signify whether they are open and looking for work, and to allow employers with quick access to a list of skilled workers. This may complement the supply chain database, which would have companies registered for parts and services to be supplied and would allow a developer to find qualified suppliers and professional talent in one location.

6.3.5. Groton U.S. Navy subbase opportunities

There are two unique and potentially interesting opportunities related to the presence of the Navy subbase related the offshore wind jobs market, including the following:

- **Retirees**: At the end of their careers, many U.S. naval personal retire out of the U.S. Subbase located in Groton. During their last year of service, the Navy provides counselling services for enlisted personnel and officers to define a path-forward for their retirement years. These retiring personnel typically have 20 or more years of service, and many retirees select locations near a military base to take advantage of health care opportunities, utilize the post exchange (PX), etc.
- **Spouses Program**: Similar to the retiree program, the Subbase also has a program wherein the Navy supports finding jobs for navy spouses. Military families are well known for having to move frequently across the Country and World to support the military's member career. Many of these spouses are themselves highly experienced in their respective professional fields and, in themselves, represent an asset to the State.

7. Recommendations for Connecticut

The following provides MME's recommendations/roadmap to support Connecticut's entrée into the offshore wind marketplace.

7.1. Governance

Create a Centralized Agency or Multi-Agency Committee Specifically Tasked Towards Offshore Wind or Clean Energy –

While Connecticut, across existing State agencies, currently has the capabilities and provides the services of a centralized-type State agency, it is currently not clear to outsiders (e.g., developers, supply chain entities, manufacturers, etc.) whom to contact and what resources are available. For instance, procurement of clean energy sources is managed by Department of Energy and Environmental Protection (DEEP); however, supply chain and development aspects of the offshore wind marketplace are managed by Department of Economic and Community Development (DECD). Workforce training programs are offered by the Connecticut Office of Workforce Strategy, as well as local Workforce Investment Boards. The Connecticut Port Authority has overall jurisdiction of State-owned port assets. Environmental impairment issues, and their associated required remedial measures, fall under the jurisdiction of another sector of DEEP. This long and evolving list of agencies can be quite confusing to potential offshore wind end users of the diverse services and programs offered by the State, especially for international entities. To provide efficient one-stop-shopping for businesses who want to work in and with the State to develop and further the offshore wind industry, it is recommended that a centralized agency or inter-agency committee be formed that can draw from all the State's knowledge base and resources. This could be as simple as a committee of appointees from each relevant department working together under an OSW-specific group that will serve as the face of Connecticut offshore wind.

Example model agencies from other East Coast states include the Massachusetts Clean Energy Center (MassCEC)[55] and New York State Energy Resource and Development Agency[56] (NYSERDA). The agencies are distinguished and recognized in the OSW industry as well-organized, knowledgeable, and well-informed resources for assisting and promoting the development of offshore wind in their respective states, as well as the Northeast region.

This recommended governmental body would need sufficient staff to actively coordinate and work with the existing developers, promote the supply chain to the industry, develop the workforce training programs, recruit firms and talent to the State, and follow through and oversee development to ensure that the State's priorities are being advanced. Further, it is imperative that a State-wide, outward-facing united front be presented: "*Connecticut is open for business, and we (the State) are here to help!*"

It is envisioned that this -new State entity would provide the concierge services for businesses seeking out real opportunities to re-locate or expand in the State; help them understand licensing requirements, tax and workforce development incentives that may exists, as well as provide an

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[55] MassCEC
[56] www.nyserda.ny.gov

overview of permitting and other regulatory requirements that will be needed to set up the business. As we understand it, those services exist, but are offered via different departments (both DECD and DEEP provide these liaison services); however, having such a prominent and active outward-facing organization to fully support the OSW industry would distinguish Connecticut from many of its peers. Within this OSW governance structure, the State should provide the critical assistance the offshore wind supply chain needs to identify and negotiate successful factory development deals within the State. Another includes that European manufacturers of primary and secondary component for OSW in general do not understand the dynamics of the ports and their development in the U.S. In the European market, federal governments are heavily involved in the development of the OSW port infrastructure., while the U.S. is currently leaving that activity in the hands of the private sector for the most part. Involvement from the State is needed to level the playing field for State port assets which are required to attract the supply chain and the European manufacturing market.

In addition to this liaison/concierge service, the centralized body could also be a tool to actively promote the State within the industry. It would be involved in OSW trade shows and conferences, such as the International Partnering Forum (IPF) by the Business Network for Offshore Wind or the WindPower Conference by the American Clean Power Association. Attending these trade shows will keep the State active and known in the industry. However, it is also strongly recommended that the State also conduct a rigorous outward-facing program to introduce the OSW industry, and associated opportunities, to other relevant industry sectors via participation as other-industry trade shows and conferences such as ACM's Aerospace Alley Tradeshow.

7.1.1. Regional Partnership

This Strategic Study is aimed at helping the State of Connecticut to stand out against its neighbors; however, such a goal is only valuable if the OSW industry achieves its potential of becoming an economic engine within the United States, especially along the East Coast. MME posits that a very effective means to help shepherd the industry forward is through the implementation of a regional partnership program with other states which have also set stringent decarbonization goals via the generation of offshore wind with the end goal of developing a renewable energy resource which will result in a consistent, reliable part of the regions electrical portfolio. There is already a basis for this regional partnership, as governors from nine U.S. states (CT, MA, MD, ME, NH, NJ, NY, RI, and VA) have co-signed a letter on June 4, 2021, to the President of the United States asking for a prioritization of offshore wind development. Further, other states have taken this approach such as the Maryland, Virginia, and North Carolina MOU to develop a Southeast States OSW Coalition. As recently as August 18, 2021, South Carolina appears to have re-entered the offshore wind marketplace and is considering/recommending more interstate coordination and cooperation.

With a more formal regional partnership, a collection of states can more actively and successfully lobby the federal government to promote key items that are needed for the industry to continue its development, such as developing a timeline for the identification of additional BOEM lease area procurements, more efficient permitting protocols, and most importantly, federal investment in infrastructure that would be used to build out and support the operations of the U.S. offshore wind industry. This infrastructure would include port redevelopment, upgrades to the energy and transmission grids, and to multi-modal transportation networks to support these infrastructure upgrades. As has been shown in the upgrades to the New London State Pier, the New Jersey Wind Port and the development of the New Bedford Marine Commerce Terminal, these port-infrastructure upgrades and projects are significant undertakings and require major financial investments on the order of hundreds of millions of dollars each. However, the industry cannot expand at the rate it is projected with only a handful ports that can support these projects; therefore, assistance through grants and loans from the federal government is a crucial piece to supporting this industry. In a classic "*which came first, the chicken or the egg?*" scenario, the specialized ports infrastructure that will be required to allow Connecticut and other states to fully support the buildout of the offshore wind industry will require significant funding, as well as design and permitting work-flow components. However, until such funds are earmarked to support these projects, no single entity such as a state, developer or port owner are currently willing to spend such monies. Further, typically no work is being conducted to permit the required infrastructure upgrades until the financial stack is fully in place. This is leading to the situation where it may potentially be very challenging to have U.S. port assets in place to support the industry, which will require developers to find work arounds. These may become a permanent part of their logistical solution even when good port facilities do come online.

7.2. Procurement Strategies

We do not have the authority to make any recommendations on State solicitations and procurements, however MME provides the following recommendations from an economic development perspective geared towards developing the OSW industry for the State of Connecticut to approach future OSW procurements:

A strategic alliance with Rhode Island could be very effective with helping both Connecticut and Rhode Island compete with other neighboring and East Coast states. Connecticut and Rhode Island have 1,100 MW and 600 MW, respectively, of OSW-derived energy that will be procuring in the relatively short term. If they can coordinate their procurements, similar to what is being done with Revolution Wind, then a 1.5 GW procurement will be prominent in the industry and help it stand up against other active states such MA, NY, and NJ. There are already elements of this alliance that can be exploited, like the shared workforce and supply chain talents servicing General Dynamic's Electric Boat.

7.2.1. Procurement Timeline

As the U.S. OSW industry is still in its infancy and, with the historical headwinds that it has faced thus far, from the demise of Cape Wind to the years-long delays in BOEM permitting, the industry players are very concerned about the short- and long-term efficacy of the U.S. offshore wind marketplace. Before earmarking and expending significant development funds, all levels of the OSW players will require a level of certainty that the market is taking off and has a long-term viability to support the expenditure of a large number of monies within the State. By way of providing such assurances, Connecticut has made the public commitment of soliciting 2 GW of OSW-derived energy on top of existing procurement authority for renewables like offshore wind. 1.1 GW is in process (304 MW for Revolution Wind and 804 MW for Park City Wind), with only the Park City Wind project counting against the 2 GW of authority, leaving 1,196 MW for offshore wind specifically.

In the 2020 Integrated Resources Plan, the State committed to conducting procurements for zero-carbon resources (not exclusive to OSW, this could include solar, onshore wind, hydroelectric, etc.) in 2023, and to meet its goal of zero carbon by 2040. The Plan identifies having its OSW procurements completed by between 2026-2028 so that contracted resources can be constructed and come online by the early 2030's. The report references that the model used in simulations indicates that an additional 3.7 to 5.7 GW of offshore wind-derived energy would be needed to achieve the 100% Zero Carbon Electricity Supply Target for Connecticut by 2040.

During our conversations with various offshore wind developers, it became clear that their involvement in anchoring various operations in a particular U.S. state will be a direct function of the size and certainly of the OSW market in that state. It was a common theme in these discussions that developers believe that they will have a higher probability of winning state energy procurements (i.e., PPAs or ORECs) if they show local content for the state in consideration, whether there are formal local content/net economic benefit requirements included in their respective state procurements. As such, developers are more willing to anchor their own operations (and potentially OEMs which would follow them) in states that have a well-defined and long-term plan for issuing future solicitations (e.g., Massachusetts, New York, New Jersey, Virginia, and North Carolina) than states such as Connecticut and Rhode Island which have not been publicly committing to such long-term offshore wind energy solicitations.

As such, MME recommends that to entice the industry and keep Connecticut attractive/relevant, the State should provide more clarity and a formal vision for its OSW-derived energy goals and procurement schedule. Massachusetts has set a goal of 4.0 GW of offshore wind by 2027, New York has set forth of a goal of 9.0 GW, New Jersey has committed to 7.5 GW, North Carolina has committed to 8.0 GW by 2040 (this is the first state-planned procurement past 2035) and Virginia has committed to 5.2 GW. The large commitments and long-term procurement schedules made by other East Coast states are keeping these states fully relevant the U.S. OSW marketplace, and thus helping them to attract the supply chain and the focus of the supporting industries.

To compete and show the supply chain that the State takes its commitment to developing the OSW industry seriously, Connecticut should set forth a clear procurement schedule and make a strong commitment to soliciting renewable, clean, OSW-derived energy, preferably past 2035 to keep the State at the forefront into the future.

7.2.2. Local Content Requirements

Local content requirements in state OSW procurements can provide mixed results for the long-term economic benefits they are intended to provide. States such as Maryland have high-local content requirements as part of their OREC solicitations, which could potentially lead to the long-term disadvantage of the state, either driving up the costs of electricity produced or generating investments that may not provide a long-term potential for growth and sustainability. These investments could result in only a short life span of a specific facility, and not provide the long-term growth that would be desired from investing in a new facility. Massachusetts and Virginia have both opted for a diminished or zero local-content requirements in their solicitations which has resulted in very-low energy costs; however, it also may make it difficult for developers and manufacturers to provide local content incentives and attract component manufacturers to either state. New Jersey, in a recent solicitation, received and accepted bids from two developers, and as a result of their local content/net economic benefit requirements, each solicitation included a proposal for a nacelle assembly facility in the state. While this represents a significant benefit to the State in the short term, the long-term projection of the industry does not seem to support the ongoing operations of two nacelle assembly facilities within one state in an economical fashion. In earlier OREC solicitations, NJ BPU did not provide specific net economic benefit targets, rather, the state evaluated each bid to balance our local content requirements and resultant higher energy costs as part of their bid review criteria.

Attempting to maximize local content through state procurements is a short term, potentially ill-advised solution, particularly with the uncertainty that currently exists in Connecticut's long-term commitment to OSW. By itself, a lower cost of energy provides a significant statewide economic impact, just in savings in operational costs to existing users. That does not even consider the benefits of generating and using clean, zero-carbon, renewable energy sources for the State, which can have a significantly positive impact on addressing climate change. Future State OSW procurements should provide precise, but not excessive, local commitments requirements. These could take the form of:

- Require the staging of O&M operations for a project within the State.
- Provide a commitment of funding to support innovation research and development for the industry to an organization (e.g., educational entity, non-for-profit group, trade organization, etc.) in the State.
- Commitments to staging deployment and marshalling out of a port facility in the State.
- Require providing clarity on the local content from the lower levels of the supply chain.
- Require that Tier 1 suppliers to the developers are held to the same standards as the developers, whereby they need to commit to using local content in the lower levels of the supply chain – in other words, confirm that all levels of the developer's supply chain are following the rules included in the energy procurements awarded by the State.
- Require follow up reporting on local content usage and project development activities, including supply chain content and stakeholder coordination (such as fisheries) on a periodic basis.
- Require supply chain coordination among the developers after award.
- Require investment in Port Infrastructure in the future State energy procurements.

MME also recommends the following two work-flow components:

- **Continued Development of an offshore wind supply-chain database.** Unlike other state databases, this should be a more outward facing database designed to reach out to a wide range of State manufacturers.
- **Travelling Shipwright program and registration**. As a supplement to the supply chain database, having an easily accessible skilled workforce database that can be provided directly to developers and supply chain participants will allow Connecticut to maximize its participation of both supply chain and workforce. Connecticut, likely in coordination with other states, should develop a web-based travelling shipwright program/database to allow skilled workers with employment opportunities. In this case, the database would be used when a skilled and experienced welder, for example is not currently needed at EB or for an OSW project due to the construction schedule of their boats, to assist a worker to find continued employment in both in the offshore wind space and other ship-building centers such as in Virginia, along the Gulf Coast, etc. This program would assist skilled works with maintaining continued employment and allow employers easier access to talent to help address fluctuations in their workflow.

7.3. Port and Infrastructure Investment

The State has already made a major commitment to OSW with its redevelopment of State Pier in New London; however, the State Pier is only one property, and while the agreement allows it to be marketed and used by other developers when it is not supporting an Ørsted/Eversource project, the industry will require multiple large waterfront facilities located in deep-water ports. As discussed above in detail above, federal support and investment will be crucial components to support the development/expansion of the port infrastructure portfolio in the country. In addition to federal support, there are several actions and activities that can be taken by Connecticut in order attract developers and users to State and private port assets, including the following:

7.3.1. Create a mechanism to fund grants to the ports for OSW development.

Provide grant funds for the ports – to be utilized as match for federal funding, private funding, or developer investment. The State should take a strong position in managing any such funding mechanisms, both to ensure that the monies are correctly utilized spent, as well as to maintain its position and relevance in this market-sector component. Following the example of New York State, where NYSERDA provided grant funds for port facility upgrades as a match to developer investment(s), Connecticut should provide grant funds for port development for OSW which will both encourage investment from developers, OEMs, manufacturers, and the supply chain to land operations in Connecticut. This will also leverage both federal grant funds (make it easier for Ports to acquire a portion of their financial stack from federal grant programs) and private investment in the Ports and in the State's supply chain.

7.3.2. Dredge Bridgeport Harbor:

The dredging of the federal navigational channel falls under the responsibility of the USACE. The USACE needs to finalize its DMMP, which based on the sediment testing results, will require the creation of a CAD) cell within the harbor to handle the unsuitable (for offshore disposal), dredged sediments. This CAD cell will need to be designed and permitted through DEEP before the dredging can begin.

> We strongly recommend that the State coordinate with the USACE to build in extra capacity within the Bridgeport Harbor CAD cell to receive additional dredge materials from other OSW-related projects within the Harbor.

The State will be responsible for 100% of the additional cost of the additional capacity, however it would have full control over its use, including charging a tipping fee for disposal into the CAD cell(s) to help recoup or offset the costs of creating that additional space.

The primary benefit of the additional space within the CAD cell is that it will allow private property owners and even state and municipal property owners to dredge their fairways more economically (i.e., the lane from the federal channel to their berth) and their berths. Given the industrial history of Bridgeport Harbor and the fact that sediments from the federal navigational channel do not qualify for offshore disposal, it is highly unlikely that the sediments from the private fairways and berths would qualify for offshore disposal. That means that cost to dredge and dispose of the sediments for these users is much higher (thereby stifling individual port redevelopment), as the sediments would likely need to be brought upland, dewatered, and disposed of at a licensed receiving facility. Disposing at an upland facility can be two-to-three times higher than disposal within a CAD cell, thereby providing significant economic incentive to the other properties owners to dredge and dispose into the CAD cell and accept the tipping fee charged by the State. A similar mechanism is currently being used for the CAD cells located in Providence Harbor and New Bedford Harbor.

For the purposed of OSW development and deployment out of Bridgeport Harbor, MME did not see the economic justification for performing the additional dredging to deepen the federal navigation channel from the -33-feet MLLW that the USACE is planning to dredge to a deeper authorized depth of -35-feet MLLW. The USACE has indicated that its economic analysis of the harbor has only justified dredging to a depth -33 feet MLLW and should the State or City desire to dredge the additional two feet, that party would be responsible for paying 100% of the cost for the additional dredge, whereas currently the only local cost share to the USACE dredging project would be the 35% local share required for the creation of the CAD cell. MME cost-benefit analysis has indicated that non-federal monies would be better spent enlarging the CAD cell to support targeted dredging programs than supporting the deepening of the federal navigation channel by two feet.

7.3.3. Promote the Ports for activities they are best suited for

Marshaling/Construction Base Ports

The New London State Pier and Bridgeport facilities of Barnum Landing, the former Derecktor Shipyard, and the out-of-service PSE&G power plant facility represent strong candidates for this type of port as they are located downstream on any bridges or other air-gap restrictions. As such, they are fully amendable for use in a traditional European fashion wherein WTIVs can access the ports, load up and transit directly to the offshore wind farms for installation. The lack of air-gap restrictions allows the installation contractors to trans-ship components in a vertical geometry which lowers the risks associated with transferring large OSW components at sea.

- **New London State Pier**: This facility has been funded, is under construction onshore, with an early 2023 anticipated completion date. The facility is leased out by Ørsted/ Eversource to support the installation of their Revolution Wind, Sunrise Wind and South Fork projects, and can be made available to other developers when those projects are not using the State Pier. Further, Ørsted has reportedly contracted with Dominion Energy to utilize their first-in-the-Nation, Jones Act-compliant WTIV. As such, the New London State Pier is the second U.S. port in line to be completed for OSW use. It is also located within reasonable steaming distance of multiple BOEM OSW lease areas located off Massachusetts and New York. As such, it is anticipated that this port will continue to be relevant to the marshaling and installation of multiple offshore wind projects through at least 2050.
- **Bridgeport Properties**: These three properties are currently under private ownership and/or by PSE&G. Avangrid Renewables is planning to use Barnum Landing to support its Park City Wind project, while there have been no reported actions associated with the former Derecktor Shipyard and PSE&G, they both have the potential for redevelopment to support future OSW operations. Bridgeport is located approximately 50 nautical miles farther away from New London and the BOEM offshore lease areas which makes their steaming distance a bit far from the New York lease areas. The area of Bridgeport Harbor will require dredging to make these sites amenable for OSW uses.

MME also recommends that the State evaluate, if the opportunity arises, purchasing the applicable portions of the PSE&G property for eventual build out into an OSW port or manufacturing center. This facility, depending on the conditions (both environmental and physical) in which it could be acquired, has the potential to be redeveloped as a major port asset for the State. Due to the location and acreage anticipated, it could be multifunctional, capable of either hosting manufacturing or as a marshalling/construction port.

O&M Ports

New London Harbor is situated in close enough proximity to the Massachusetts and Rhode Island BOEM offshore wind lease areas to support crew transfer vessel (CTV) operations, while Bridgeport Harbor is less attractive due to steaming distance issues. Both harbor areas are located sufficiently well to support SOV operations. MME makes the following recommendations with respect to potential O&M support bases:

- **CTV Port**: The City of New London should study the potential to develop the Fisherman's Landing property into a CTV operations base. It is well located to provide such services and could easily support the O&M operations of multiple offshore wind operators. Mohawk Northeast's New London facility is also a good candidate for a CTV port.
- **SOV Ports**: Due to longer allowable steaming distances, SOV support ports can be located further away from the wind farms that they service. We anticipate that there will be significant inter-state competition to attract these types of facilities. While the State should not discount use of its ports to support SOV operations, MME recommends that this not be a primary focus for the State. It should be noted that any of the Bridgeport properties could relatively easily pivot to use as SOV ports should there be a future period where marshaling/construction base-type operations slow down.

Higher Tier Manufacturing Ports

As discussed above, the main assets the State has to offer new manufacturers of higher-tiered OSW component are State fiscal incentive programs and large, vacant waterfront properties. For the purposes of this Strategic Study, MME recommends that the State explore possibilities and interest on the following two properties:

- **Pequot Landing**: This approximately 500-acre parcel is currently undeveloped, is owned by the Mashantucket Pequot Tribe and is located approximately four miles up the Thames River from the New London State Pier facility.
- **Former Norwich Hospital Site**: This 393-acre brownfield site has been vacant since the State shuttered the hospital's doors in 1996. The former Norwich Hospital property in Preston, which Mohegan Gaming & Entertainment (MGE) and the Town have an ownership transfer agreement on, is currently undergoing remediation. If MGE discontinues interest in the property, the property could possibly be of interest to the OSW industry.

Both these properties are strong candidates for use as higher-tiered manufacturing facilities as they have direct waterfront access, as well as intermodal rail and roadway access. It is important to note that both properties will have overhead height restrictions and, therefore, components manufactured at either facility would be too large for road or rail transport and would require shipment by barge to their respective delivery locations. This barge strategy is similar to what is being proposed at the Port of Albany in New York for the tower-manufacturing operation.

7.4. Supply Chain

MME provides the following recommendations associated with attracting the OSW supply chain to the State.

7.4.1. Active Advocacy -

The Park City Wind and Revolution Wind developers frequently conduct *Meet the Buyers* events where they connect with potential members of the supply chain – it should be noted that the OSW developers recommend that supply chain entities confer with OEMs as these parties will be the ones actually procuring manufacturing services. The State should use that principle by acting as a liaison for developers and Tier 1 component manufacturers active in the State, something in the form of a *Meet Your Future Supply Chain and Experts* event. This would include reaching out to OEMs and Tier 1/2 suppliers to introduce them to the talent pool and existing companies and associations currently working within the State. While supply chain databases and meet the buyer events are effective, they are somewhat passive tools as the potential supply chain members need to be actively looking and involved in order to become part of the offshore wind marketplace. Actively recruiting an OEM and introducing them to the capabilities that exist within the State expands the footprint of the outreach and may trigger supply chain entities or needs that were not being actively pursued. Further, there should be a rigorous outreach program to existing Connecticut manufactures introducing them to the OSW marketplace and both the short- and long-term opportunities associated with same.

7.4.2. Innovate -

This report focusses on the existing needs of the OSW marketplace, where it is projected to go in the near-, mid- and long-term future, and evaluate potential paths forward for the State to successfully enter the industry. It should be noted that the OSW industry, which is currently European-based, will need to evolve over time to mature into the U.S. market –remember that there are only seven WGs currently operating in U.S. waters, but thousands of WTGs will be installed over the next decade or so. As such, the industry we see today will likely not resemble the industry of 2030, which is only nine years in the future. Connecticut's *can-do attitude* will be fully supportive of the industry agility which will be required to support the evolution and adaptation over the coming years in ways that are not even feasible today. As an example, the originally planned first OSW project, Cape Wind, envisioned to deploy in the middle of the 2010's was going to use 3.5 MW turbines and at the time, no turbine was anticipated to be larger than 7 or 8 MW. Now, less than a decade later, WTGs are being pushed to 15 MW. Similarly, the current generation of OSW turbines are fixed foundation type; however, there is a significant amount of research and development being invested into floating foundation technology, which would enable development in an enormously wider area of the oceans as floating WTGs can be installed in much deeper waters. Additionally, use of concrete GSB-type foundations may address concerns over acoustical impacts to marine life during the installation of the foundation elements of an offshore wind farm. There are also significant opportunities for energy storage, through developing technology with batteries, hydrogen and grid storage that could lead to new areas of growth for OSW and energy programs in general.

Connecticut is a state steeped in history and talent for innovation. Programs like the Connecticut Center for Advanced Technology (CCAT) were initially instituted in 2004 in the State to develop technologies and innovations that could make change on the global wind market.

Connecticut Opportunity: The State should be actively involved in the development of new and innovative technology through an organization such as the National Offshore Wind Research and Development Consortium (NOWRDC).

There are already several state entities actively involved in NOWRDC, including NYSERDA, MassCEC and Virginia DMME, amongst others. This group is dedicated to developing innovation and technology to help OSW grow. Pairing the capabilities of an agency like CCAT with the knowledge and development of NOWRD could help develop technologies and keep Connecticut on the forefront of the OSW market and will result in the State being proactive in the development of the industry.

7.4.3. Focus on the State's Strengths –

Many of the East Coast states are focused on bringing in a large Tier 1 supplier/manufacturer to their states. There are already several Tier 1 companies setting up in the U.S., so these opportunities are becoming fewer based on what the industry will be able to support in the near term. There are, however, significant opportunities in the lower levels of the supply chain such at Tier 2 and Tier 3 entities who would supply to the OEMs, that will allow for market capture of not just the U.S. market, but the global OSW market. Connecticut has the existing capabilities to support these OEMs, with its advanced manufacturing and innovation programs. The State should be actively promoting these sectors to OEMs and higher end supply chain entities. Focus on manufacturing sub-assemblies of nacelles and getting into the global supply chain of these OEMs.

One valuable means to effect communications between OEMs and State resources is to actively recruit them, not to develop and install large-scale manufacturing in the State, but to make the connections with those companies and the existing companies that are already present and operating exist within the State necessarily initially. An example would be to recruit a turbine OEM like GE, Siemens Gamesa, or Vestas, and have them meet with the Naval Maritime Consortium or the Aerospace Components Manufacturing Association to discuss needs and capabilities.

The State's advanced manufacturing capabilities will allow Connecticut with an early entrée into the developing OSW marketplace and should focus on manufacturing of corrosion-resistant (required due to the harsh marine environment in which they will be installed) Tier 2 through Tier 4 components, including the following:

- Nacelle sub-components including gears, bearings (such as plain bearings, which are commonly used in aerospace), seals, stator coils, brakes, driver shafts, coolant/lubrication systems, etc. Nacelles are made up literally of thousands of smaller-scale subcomponents which are too numerous to enumerate herein. As such, nacelle "*manufacturing*" facilities are actually properties where the thousands of subcomponents are assembled into functioning nacelles
- Electrical Discharge Machining – A key skill set used in the Aerospace industry, is also relevant and needed for the complex geometries of a wind turbine.

- Supervisory Control and Data Acquisition (SCADA) systems.
- Secondary steel sub-components (e.g., platforms, ladders, tie-off lugs, etc.).
- Turbine head pitch/yaw controls.
- Brake components.
- Wiring and coils; and,
- Miscellaneous small/minor components including highly specialized nuts, bolts, washers, cotter pins, screws, and gaskets, to name a few.

The aforementioned list focuses on the WTGs themselves and does not consider the universe of other direct infrastructure and equipment needs including ports, helicopters, small- and large-specialized vessels, inter-array cables, export cables, etc., all of which existing State firms are fully capable of manufacturing.

Due to the OSW industry's nascent stage in the U.S. and the competitive nature of the industry with proprietary information, it is currently not feasible to accurately identify the number and types of sub-components which the OEMs will require to complete their respective Tier 1 components (i.e., foundation elements, transition pieces, towers, cables, and nacelles). Given an estimated 61.78 GW (61,780 MW) of anticipated offshore wind-derived energy in the U.S. through 2050 (with a potential for up to 110 GW), and an average anticipated WTG capacity of 15 to 20 MW, there will be approximately 3,000 to 4,000 WTGs installed in U.S. waters over the next 30 years. According to one source[57], there could be up to 1,400 GW of offshore wind-derived energy globally by 2050. Assuming a 20 MW WTG capacity, this results in well over 60,000 WTGs being installed in global waters. As such, both the U.S. and international OSW market promise to be large and stable for many years to come.

It should also be noted that the State needs to move quickly in implementing its strategies to attract the offshore wind supply chain. With BOEM's recent approval of the Vineyard Wind 1 project, the offshore wind industry is in the process of taking off, the time is now for the State to act to secure its role in this multi-billion-dollar industry.

7.4.4. Develop a strong outward facing outreach program –

As discussed above, the State's OSW program should develop an outward facing outreach program to State manufacturers and maritime service providers who may not currently be involved in the offshore wind industry. The primary recommended means of conducting these outreach programs include the following:

- **Develop and Maintain an OSW Database**: It is understood that CCAT is currently preparing such a database. Many other states and developers have their own databases which tend to be stagnant and of little real use to the wide range of entities which could profit by them. MME recommends that the State review how the current supply chain directories information has been developed, input and is utilized and/or underutilized to determine how supplemental information can enhance the Connecticut's database.

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[57] 1,400 GW of offshore wind energy is possible by 2050 | REVE News of the wind sector in Spain and in the world (evwind.es)

This should include the development of an on-line questionnaire to acquire data from a wide range of respondents including technical capabilities/capacities, volume capacities, levels of interest in the offshore wind marketplace. The State should work closely with suppliers to generate feedback and reach a wide variety of markets that are or could in the future be applicable to offshore wind including cable manufacturers, concrete suppliers, steel suppliers, electronic / control systems firms, and research organizations. The results of this survey should be cleaned, processed, and mapped based on respondents addresses, to provide a database. This will also allow for the State, developers, and supply chain entities to query the database to provide statistics on various database parameters such as number of processed and mapped based off respondents addresses to provide a database.

- **Existing Business/Manufacturing Associations**: There are several Connecticut business/manufacturing associations which have literally thousands of individual members including, but not limited to the Aerospace Components Manufacturers, the Connecticut Manufacturing Association, and the Smaller Manufacturers Associations. The Naval Maritime Association is currently developing a database to help with the Electric Boat supply chain. It is strongly recommended that the State initiate a program to interact and integrate with these associations as a force multiplier. That is, utilize their existing member data bases to reach out to the thousands of State businesses that may not otherwise be knowledgeable about the developing offshore wind marketplace. Further, the State should consider attending and participating in various non-OSW conferences and trade shows where various maritime service and manufacturers gather.

7.5. Workforce Training

Workforce training programs need to start at the high school level to create a pipeline of talent. A lot of these programs exist; however, they need to be promoted more. Vocational training and apprenticeships will get workers involved in skilled trades early and consistently, helping to create this pipeline. GWO certified training is a must for all construction and O&M personnel, so the State should actively promote its existing GWO training programs (and those in development) to keep that pipeline of talent ready for more skill specific activities.

MME does see the need for support and program development for targeted OSW workforce areas, notably, welders, pile drivers, and OSW engineers and science related fields, as discussed below:

- **Welders and Pile Drivers** – This skilled workforce can be developed starting in vocational high schools through community colleges, and the State should be setting up apprenticeships and training programs to meet the anticipated demand and experience requirements for welders. These workers will not only serve the OSW industry, but also the maritime (e.g., Electric Boat) and construction industries. Similarly, pile drivers are a skilled trade group that would require early career job training and provide a skillset that will be transferrable across OSW, maritime and construction industries. Currently there exists only one program, through Mass Maritime Academy, for training pile drivers for OSW activities.
- **OSW Engineers and Scientists** – Connecticut has a group of highly-respected science and engineering colleges and universities, and by setting up programs for offshore wind Engineering/Sciences, the State can develop a solid pipeline of professionals trained in the multiple engineering and science disciplines required to support OSW. An advantage of developing OSW engineers and scientists is that they won't be limited to working solely on

OSW projects within the immediate vicinity of the State, but throughout the Country. Connecticut can position itself as the knowledge center of the OSW industry for the State with professionals designing, planning, and permitting projects nationally - as well as the aforementioned innovation/incubation center. Connecticut is flush with such high-quality engineering and science development programs starting in high school and available in the community colleges, as well as its four-year universities and graduate programs, all of which will provide future workers to the OSW marketplace. Further, there are highly trained and highly experience engineers and scientists living in Connecticut who can easily and effectively pivot to provide senior-level support and services as the OSW industry evolves. Because OSW programs require a multi-disciplinary team of geophysicists, structural engineers, geotechnical engineers, mechanical engineers, geologists, oceanographers, ecologists, biologists, meteorologists, fishery experts and electrical engineers, among others, the State should continue to support and promote the development of these talent pools.

The State should also work with the Groton Subbase to integrate both their retiree and spouses' employment programs. This will result both in leveraging the skills of both of these highly skilled and experienced work forces as well as keeping these citizens and their families in the State.

Another recommendation is to support the development, opening and operations of an OSW innovation center. This would act as an incubator for State residents and businesses to aid them in their own entrée into the offshore wind market. The incubator concept is a great way to advance and innovate new technologies that are needed and developing related to offshore wind, which is where a significant economic benefit exists. This is completely analogous to MME's recommendation to focus on existing State manufacturers of lower-tiered components. There are similar incubator programs including the New Bedford Ocean Cluster, which is promoting the blue economy, including offshore wind, in the New Bedford region and the Cambridge Innovation Center in Providence which includes Ørsted's Innovation Hub and offices of Crowley Maritime.

As a final note associated with this issue, MME offers the following: many of the manufacturing jobs, especially those associated with lower-tier components, can be conducted by existing State entities – again, this ability to easily pivot to manufacturing of OSW components is a primary strength of Connecticut. As such, MME believes that existing State and industry training programs (such as vocational apprenticeship programs) on the trade/technical school level are sufficient to support this sector of the offshore wind industry; however, we do note that the State has already stated that, as of 2019, the demand for manufacturing workers exceeded the supply by 3,000 jobs per year. The challenge lies not in creating the training programs, but in steering young Connecticut-based talent into those programs. It is believed that natural market forces exerted as the U.S. offshore wind industry ramps up will drive enrollment into such existing training programs and developing new programs will not be required. However, the founding of the recommended innovation center/incubator will support State businesses with an entrée into the OSW marketplace by educating the public regarding the opportunities of OSW, as well as provide a launching point for OSW practitioners to meet and hire Connecticut talent, and most importantly innovate and create new approaches for offshore wind.

7.6. Developer Financing for Upgrades

Streamline, clarify, and amplify State incentive packages that manufacturers and service providers in the OSW industry can enjoy if they commit to working with a State port to build OSW manufacturing capacity in Connecticut. To that end, conduct a full review of all of the economic incentives, financial support, and finance structuring (i.e., RI has provided significant tax relief packages to Ports that have the potential for creating local employment – the private port of East Providence received a $14M tax relief package to assist with the financial development of the Port – that funding leveraged private investment in the Port for OSW as financiers saw the State back the Port because of its involvement in OSW). Once a review of all potential incentive packages has been completed, develop a clear, concise, yet comprehensive industry-specific Guide to Financial Incentives for the OSW Industry for ports factory development for potential manufacturers and service providers. Conduct direct outreach and marketing to the Tier 1 and Tier 2 OSW manufacturers. Amplify the potential to leverage the already existing industry players in the aerospace and marine technology in Connecticut.

7.7. Keep the Citizens of the State Informed and Excited

One of the State's strongest assets is its highly experienced and qualified workforce which affords Connecticut and the OSW industry with the skill sets required to quickly support the first-mover Offshore Wind projects slated for development off the U. S. East Coast. This study has focused primarily on promoting industry and working with existing business entities; however, the OSW should also be promoted to the public. The implementation of an effective and ongoing public outreach program is recommended to provide the citizens of the State with an understanding of the opportunities represented by offshore wind and inform taxpayers of workforce training opportunities. The program should aim to keep the citizens excited about the existing and future economic opportunities associated with the OSW industry and provide guidance on how they can take advantage of these opportunities. This outreach program should promote not only the economic benefits of offshore wind, but also the environmental benefits associated with generating clean, reliable, renewable energy to all the citizens of Connecticut. Offshore wind is a proven technology with over 25 years of implementation in Europe, it provides clean energy from a region with consistent winds, and is the source of jobs and economic benefits, all of which will benefit the citizens of Connecticut.

OSW is an exciting and rapidly developing industry, and with this focus and dedication, the State of Connecticut can establish itself as a center of knowledge and be a major contributor to the U.S. and worldwide supply chain. The next three decades are likely to provide rapid growth and significant economic impact, so these strategic actions and investments made in the near term will provide benefits and rewards for years to come.

8. Limitations and Assumptions

In developing this report, MME and its partners made our best efforts to contact as many resources and parties as we could, however given the project timeline and our breadth of activities required for this project, we were not able to reach everyone we had wished to interview. Similarly, there are many sites, port facilities and manufacturers within the State that we weren't able to visit or meet with. The information we have provided in this report is based on either publicly available data, interviews and discussions with relevant parties and any primary source material that we were provided as part of this study.

This report was commissioned by the Eastern Connecticut Chamber of Commerce, with support from the Revolution Wind team. While this Study attempts to address statewide capabilities and make recommendations for the State of Connecticut to implement, it is not a document generated by or on behalf of the State of Connecticut, the Governor's office, or any State Agency.

Assumptions, analysis, and recommendations made as part of this report were made strictly from the perspective of OSW and to generate an economic impact from OSW activities. We did not compare the proposed OSW-focused recommendations against other economic development opportunities and there may lie other more attractive Non-OSW opportunities for the ports or supply chain entities.

As noted, the property and port facility assessments were made independently of any of the property owners and developers, and often without contact or consultation from them. These properties may or may not be available for OSW development, but our inclusion in the report does not imply that they are available for development redevelopment. Our inclusion in this report is only to show that should these facilities became available or show interest in development, then there is potential for use as an OSW facility.

Furthermore, the OSW industry is rapidly developing and evolving. The projections and estimates we have made are based on a snapshot of the current vision and expectations of the industry. Federal and state programs, as well as investment from private industry, can significantly influence which direction the industry heads. Similarly, technology is constantly improving and can change how WTGs are manufactured, assembled, constructed, and maintained. This study evaluated the existing methodologies and the likely technologies that will be developed and deployed in the future.

This document should be considered a living document, that should be revisited and updated as the industry progresses and develops. Connecticut has great assets and a lot of potential for OSW, and it should continue to grow and evolve its strategy as the industry grows and evolves.

9. List of Figures and Plans

Ports Evaluated for this study

Figure 75 Potential Offshore Wind Marshalling/Manufacturing Ports

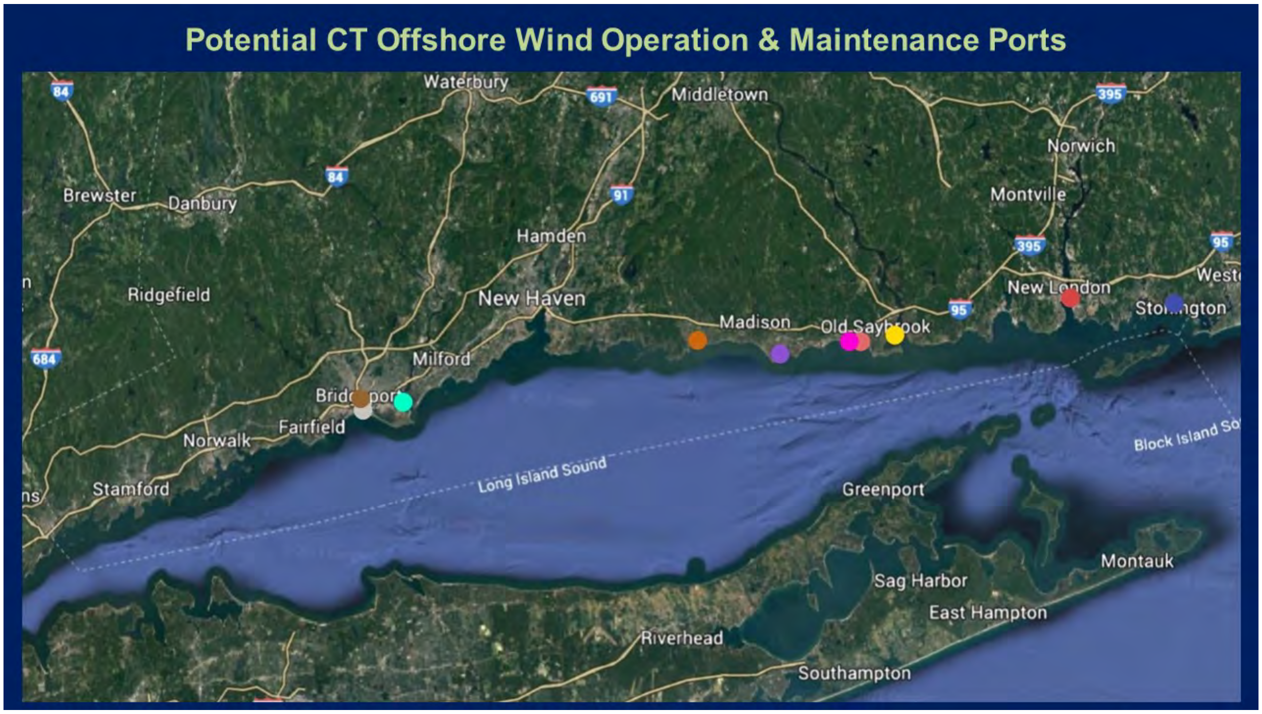

Figure 76 Potential Offshore Wind O&M Ports

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